FEDERATION OF NIGERIA

Annual Report

on the

Department of Agricultural Research

1958-59

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FEDERATION OF NIGERIA

Annual Report on

the Department of Agricultural Research

for the year 1958-59

Contents | Page

Staff List 1

Report by The Director 3

Progress in Research

- Soil Fertility Investigations 9
- Improvement of Food Crops 10
- Control of Plant Diseases and Pests 20

Library 36

Publications 36

Appendices

- Table I. Rate of Recruitment of Specialist Officers
- Table 2. Coffee Variety Yields
- Table 3. Berry Borer Infestation of Coffee
- Table 4. Locust Activity in Nigeria
- Table 5. Meteorological Data, Moor Plantation
- Table 6. Meteorological Data, Badeggi
- Organisation Chart

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FOREWORD

The importance of Agriculture in an under-developed country like Nigeria cannot be over-emphasized, especially as it is well-known that Agriculture is the mainstay of the country's economy. In the circumstances, there can be no doubt that an expansion in Agricultural exports will correspondingly increase the country's wealth. Research, therefore, into better methods of cultivation, aimed at improving and increasing crop yields and providing new varieties resistant to diseases and pests attack must be intensified.

The Department of Agricultural Research has been confronted with two major problems, namely, the difficulty in recruiting the required scientific staff and the lack of the necessary facilities to implement the projects envisaged in the Economic Programme. It is hoped that with the new conditions of service which are now offered to scientists qualified to undertake research and the encouraging signs of qualified Nigerians emerging in the field, the present unfavourable staff position will improve. Furthermore, it is anticipated that with the establishment of the proposed soil fertility unit, intensified study of the problems of Nigerian soils can be undertaken.

On the whole, the year under review indicates to a considerable extent, the contributions that the Department of Agricultural Research is making towards the economic and agricultural development of this country.

SHEHU SHAGARI
Minister of Economic Development.

STAFF LIST AS AT 31ST MARCH 1959

MOOR PLANTATION, IBADAN

Director of Agricultural Research
Dr. J.M. Waterston, Ph.D.(Edin.), B.Sc., A.I.C.T.A., F.L.S.

Deputy Director
J. Robinson, B.Sc., Ph.D. (London), F.R.I.C.

Librarian
C.M. Petrie, M.A. (St. Andrews), Ph.D. (Edin.)

Secretary
Miss. A. O'Kane

Higher Executive Officer
M. I. Ntephe

Principal Research Officer
F.A. Squire, B.Sc. (Rhodes), A.I.C.T.A.

Specialist Officers
A.G. Bailey, B.Sc. (London), D.A.S., D.T.A., M.Inst. Biol.
Plant Pathologist

B.D.A. Beck, B.Sc. (Manc.), D.A.S., D.T.A.
Botanist

+P.M. Chinwuba, B.A. (California), B.Sc. (Lincoln), M.Sc.
(Missouri) Agronomist

J.L. Gregory, B.Sc. (~~Bristol~~ SHEFFIELD), D.A.S., D.T.A., F.R.E.S.
Entomologist

K.M. Harris, B.Sc. (Wales), D.A.S., D.T.A.
Entomologist

C.R. Parsons, B.Sc. (London), Dip.Hort. (Seale-Hayne)
Chemist

D.G. Robertson, B.A. (Oxon.), D.A.S. Plant Pathologist

R. Spencer, B.Sc. (London), B.Sc. (Exon), Plant Physiologist

P.E. Udeaja, B.Sc. (Manitoba), M.Sc. (McGill)
Plant Pathologist

A.W. Waitt, B.Sc. (Edin.), D.A.S., D.T.A.
Botanist

Technical Officers

A. O. Bamtefa

M. J. Ekandem

F. O. Iwenjora

J. A. Marden, Dip.Hort., (Wisley), Kew Cert.

E. D. Oddy, Dip.Hort., (Wisley)

J. K. Olurin

W. A. Porter, N.D.A., C.D.A. (Glasgow)
Station Manager

BADEGGI SUB-STATION

Senior Specialist Officer
J.E.Y. Hardcastle, B.Sc., (Dunelm), D.A.S., D.T.A.
Botanist

Specialist Officers
F.C. Bent, Ph.D. (Cornell)
Agronomist

G. Jenkins, B.Sc. (Wales), D.T.A.
Botanist

Ir. J.A.F.M. Sluyters, M.Sc. (Wageningen) l.i. (Wageningen)
Plant Breeder

Technical Officer
S.G. Jackson, Hort.Cert.(Edin.)

Research Fellowships

P. Ward, B.Sc.(Liverpool), D.I.C. Quelea Investigations
University College, Ibadan

C.N. Williams, B.Sc.(Natal) Striga Investigations
University College, Ibadan

West African Maize Research Unit

Senior Scientific Officer
R.H. Cammack, B.Sc., Ph.D. (St. Andrews)

Scientific Officer
Ir. C.L.M. van Eijnatten, l.i. (Wageningen)

+ Specialist Officer on secondment from the Federal Department of Agricultural Research to the West African Maize Research Unit

ANNUAL REPORT ON THE DEPARTMENT OF AGRICULTURAL RESEARCH, FEDERATION OF NIGERIA, FOR THE YEAR 1958-59.

REPORT BY THE DIRECTOR

Introduction

There were no major changes in policy during the period under review. The main lines of investigation followed those of the previous year and included studies on the factors affecting soil fertility, the improvement of food crops and the control of plant diseases and pests. Details will be found under these headings in the sections dealing with the progress of research which follow this report.

The problem of recruitment and retention of scientific staff continues to be serious, but it is heartening to record that some improvement in recruitment was shown during the year, which included the appointment of two Nigerians as Specialist Officers. There are a further ~~ten~~ Nigerians two undergoing University training to qualify themselves for professional appointments in the Department, which is at present 56 per cent under-staffed.

Organisation

Progress of research work has been severely hampered during the past three years not only by a shortage of staff but also by inadequate facilities. Negotiations with the Western Region Government on the matter of re-apportionment of facilities at Moor Plantation, however, were successfully completed during the year. This will now permit the implementation of the projected expansion of Federal research facilities which is envisaged in the Economic Programme in the Western and other Regions.

Sir Frank Engledow, C.M.G., F.R.S., former Drapers Professor of Agriculture, Cambridge University, visited Nigeria towards the end of March to advise on the re-organisation of the Federal Departments responsible for agricultural, veterinary foresty and fisheries research. His survey of Nigeria was still under way at the end of the period under review.

Staff

The Department suffered the loss through resignations of four senior officers during the year:- Dr. S.R. Chant, Plant Pathologist; Mr. J.A.R. Bates, Chemist; Mrs. T.C.N. Baker, temporary Specialist Officer; and Mr. J.K.C. Dunlop, Chemist (Rice Research). These losses were offset by the appointment of Dr. J. Robinson as Deputy Director; Mr. A.G. Bailey, Mycologist, transferred from the Northern Region Ministry of Agriculture; Mr. D.G. Robertson, Plant Pathologist (virology); Mr. P.E. Udeaja, Plant Pathologist (nematology); Mr. R. Spencer, Plant Physiologist; Mr. C.R. Parsons, Chemist; Mr. J.A.F.M. Sluyters, Botanist (Rice Research); Dr. F.C. Bent, Agronomist (Rice Research); and Mr. P.M. Chinwuba, Agronomist (seconded to the West African Maize Research Unit).

In addition, the vacant Quelea Research Fellowship was filled by the appointment of Mr. P. Ward. Against this notable increase in the rate of recruitment must be offset the number of retirements which was also high, so that the net gain to the establishment amounted only to five as shown in Table 1. The rate of turnover of professional staff during the past eight years has averaged 56 per cent. Drastic measures to improve conditions of service are needed if this unusually high rate is to be halted.

The authorised establishment of senior staff at the beginning of the year and the actual strength at 31st March 1959 are given below. It will be noted that there was a total of 35 vacancies in an establishment of 76.

Professional	Authorised	Actual
Director	1	1
Deputy Director	1	1
Principal Research Officers	5	1
Senior Specialists and Specialists	33	13
Scientific Officers (Soil Fertility Unit)	2	-
Librarian	1	1
Sub-Total Federal Research	43	17
West African Maize Research Unit		
Research Officers	3	3*
Total Professional Staff	46	20
Higher Technical Staff		
Technical Officers	4	4
Assistant Technical Officers	14	10
Laboratory Technologists	5	3
Assistant Laboratory Technologists	2	2
Station Managers	2	1
Total Higher Technical Staff	27	20
Executive		
Higher Executive Officer	1	1
Executive Officer	1	-
Records Officer	1	-
Total Executive Staff	3	1
Grand Total Senior Staff	76	41

* Includes one supernumerary Specialist Officer seconded to the West African Maize Research Unit.

The corresponding position for Junior Staff at 31st March 1959 showed a total of 70 vacancies in an establishment of 229, as follows:

Clerical		
Chief Clerk	1	1
Secretary-Typist	1	1
Assistant Chief Clerks	2	2
First Class Clerks	10	5
Second and Third Class Clerks	27	23
Library Assistant	1	1
Total Clerical Staff	42	33
Technical		
Senior Agricultural Assistants Grades I & II	7	2
Agricultural Assistants Grade I	9	5
Agricultural Assistants Grades II & III	55	40
Second and Third Class Agricultural Laboratory Technicians	6	3
Photographic Assistant Grade I	1	1
Draughtsman Grade II	1	1
Total Technical Staff	79	52
Minor Technical and Clerical (Scale F)		
Senior Field Overseers	6	4
Field Overseers Grades I & II	57	33
Artisans	8	5
Driver Mechanics	7	4
Clerical Assistants	12	11
Total Minor Technical Staff	90	57

Sub-Clerical and Minor Technical (Scale G)	Authorised	Actual
Laboratory Attendants	6	5
Telephone Attendants	3	3
Messengers	9	9
Total Sub-Clerical and Minor Technical	18	17
Grand Total Junior Staff	229	159

As will be seen below, there are at present 200 substantive holders of posts in an establishment of 305, leaving 105 vacancies.

	Nigerian	Expatriate (P)	Expatriate (C)	Vacant	Total
Professional	2	10	8	26	46
Higher Technical	16	-	4	7	27
Executive	1	-	-	2	3
Clerical	32	-	1	9	42
Technical	52	-	-	27	79
Minor Technical	57	-	-	33	90
Sub-Clerical	17	-	-	1	18
Total	177	10	13	105	305

(P) = Pensionable (C) = Contract terms

It is gratifying to record the appointment for the first time of two Nigerians to professional posts in the Department.

Nigerians undertaking higher training at the present time to qualify themselves for posts in the Department are as follows:-

	Diploma	B.Sc.	M.Sc.	Total
Agriculture	1*	4	1*	6
Botany	-	5	-	5
Chemistry	1*	1	-	2
Entomology	-	-	1*	1
Total	2	10	2	14

* These officers are at present holding posts in this Department and are undertaking further studies to qualify themselves for more Senior positions.

PROGRESS IN RESEARCH

The following is a summary of the progress made with research projects during the year. Fuller details are contained in a later part of this report. Soil fertility investigations. The Chemist completed a preliminary study of organic matter in a typical forest soil near Ibadan. The distribution of phosphorus was also studied. These studies have shown that there is a rapid decrease in the C/N ratio on passing from the 0-2" layer to the 2-7" layer, below 7" the C/N ratio decrease slowly with depth. The C/N ratio of the soil samples after treatment with two extractants (sodium hydroxide and sodium pyrophosphate) has also been studied. The fulvic acid complex at the forest soil has been separated into four major fractions by the Forsythe technique.

The amount and distribution of phosphorus in a forest soil and a cropped soil has also been investigated; the clay fraction has the highest content of total and organic phosphorus. It has been found that the available phosphorus content of the sand fractions is strikingly low.

With the recruitment of a plant physiologist studies on crop nutrition can now be started. Investigations of the major element requirements of the various crops will first be undertaken, and the necessary equipment and chemicals are being ordered for these investigations. Preliminary studies of the soil/plant/water balance are also in hand; evapotranspirometers and lysimeters are to be installed.

Improvement of food crops: The aim of the food crop improvement research programme is to produce new varieties which combine inherently high yields with disease and pest resistance. Thus, the Botanist has produced cassava hybrids which have a potential yield four times as great as existing varieties. These are to be further tested in the Regions during 1959/60 before they are released.

Good progress has been made in the improvement of rice varieties. Four 5-month varieties (D114, D52/37, D99 and Mas 240) which were introduced to replace BG 79, the present dominant variety, and GEB 24 in the non-inundated irrigable lowlands, have been shown to outyield these old varieties by 15 - 25 per cent. They will be released to the Regions as soon as a laboratory assessment of milling and cooking quality has been completed. The Tropical Products Institute, London is co-operating in studies on the nutritive value of Nigerian rice varieties.

Other important lines of work which are being maintained at the present time include studies on kola and coffee.

Control of Plant diseases and pests: Further studies of the virus diseases affecting cowpeas have revealed two distinct types; one is a strain of tobacco mosaic virus and the other, causing more severe symptoms, has been named cowpea yellow mosaic virus. Plans are now under way for devising measures for the control of these viruses in the field.

Trials at Ibadan of citrus rootstocks tolerant to the virus disease tristeza are now beginning to show results. Sour orange is a most susceptible stock for both acid lime and sweet orange, whilst Cleopatra mandarin and the grapefruit x mandarin hybrid (Lake Tangelo) appear to confer tolerance.

Experiments on the control of yam beetles continue to indicate that seed dressing with insecticides is the most effective method, with Aldrin and Cammalin A proving the best of the insecticides tested.

Research Fellowships: The Research Fellow for studies on plant pests (Witchweed, Striga spp.) has been engaged on investigations into the physiology of parasitism with a view to the development of agricultural practices designed to control this parasitic weed. The Research Fellow for Quelea bird studies was appointed at the close of the period under review and will take up his duties in June 1959.

VISITING MISSIONS

Mr. James H. Smith, junior, Director of International Co-operation Administration - a body which administers United States foreign aid - visited Nigeria in November 1958 with a party of experts to explore the possibilities of greater utilisation of scientific resources of the United States and other countries in attacking the problems of under-developed territories in tropical Africa.

No report by the Mission has been made public by the end of the period under review.

MEETINGS OF RESEARCH WORKERS

An event of importance to local scientists was the inauguration of the Science Association of Nigeria at a meeting held at the University College, Ibadan on the 19th December, 1958. The Association is to be affiliated with the West African Science Association and should prove an invaluable means of encouraging scientific research.

A series of research seminars held at fortnightly intervals were well attended by members of the Department of Agricultural Research, the Western Region Ministry of Agriculture and Natural Resources, the West African Cocoa Research Institute, the West African Maize Research Unit and visiting scientists from the International Development Services and the University College, Ibadan. These meetings not only ensure liaison among research workers at Ibadan but are stimulating to young research workers.

Dr. J. Robinson, Deputy Director of Agricultural Research, was a member of the United Kingdom delegation which attended the F.A.O. First Technical Cocoa Conference held at Accra, Ghana from the 7th - 16th February 1959.

INTER-TERRITORIAL RESEARCH COMMITTEES

Meetings of the Management Committees and Technical Sub-Committees of the West African Cocoa Research Institute and the West African Institute for Oil Palm Research were regularly attended and the needs of all Regions kept in view.

COLONIAL DEVELOPMENT AND WELFARE SCHEMES

West African Maize Research Unit: Breeding work continued as in previous years on the production of inbred lines with the ultimate aim of obtaining synthetic maize varieties. Dr. G.D.H. Bell, Director of the Plant Breeding Institute, Cambridge, who is also a member of the Committee for Colonial Agricultural, Animal and Health and Forestry Research, visited the Unit in February and made some useful suggestions for the future programme of work.

DISTINGUISHED VISITORS

The Department was honoured by the following distinguished visitors to its headquarters:

H.E. Sir James Robertson, G.C.M.G., G.C.V.O., K.B.E., Governor-General of the Federation, and Lady Robertson; the Hon. Victor Mukete, M.H.R., Minister of Research and Information; the Hon. P.O. Nwoga, Minister of Agriculture, Eastern Region; Dr. M.S. du Toit, F.R.S., Secretary-General, C.S.A; Mr. James H. Smith, junior, Director, I.C.A., U.S.A; Lord Milverton, Director, Bank of West Africa; Dr. G.A.C. Herklots, Principal, Imperial College of Tropical Agriculture, Trinidad; and Sir Frank Engledow, C.M.G., F.R.S.

Visitors to the Rice Research Station, Badeggi, included:

H.E. Sir James Robertson, G.C.M.G., G.C.V.O., K.B.E., Governor-General of the Federation, and Lady Robertson, and the Hon. Victor Mukete, M.H.R., Minister of Research and Information.

Visits by Agricultural Research Specialists to Neighbouring Regions and Territories:

Dr. J.M. Waterston, Director, visited the Eastern Region in October and Mokwa and the Federal Rice Research Station in November. He attended the Managing Committee of the West African Cocoa Research Institute, Tafo in February 1959. He visited the Federal Department of Veterinary Research in February and toured the Northern Region in March 1959, visiting the Federal Rice Research Station, Badeggi.

Dr. J. Robinson, Deputy Director, visited the West African Institute for Oil Palm Research, Benin and toured the Eastern Region in September. He visited the Regional Research Station, Samaru in October and the Federal Rice Research Station, Badeggi in December.

Mr. J.E.Y. Hardcastle, Senior Specialist Officer in charge of the Federal Rice Research Station, attended a meeting of the West African Inter-Territorial Secretariat in Accra in July. Mr. G. Jenkins visited Birnin Kebbi in May and Bauchi, Plateau and Bornu Provinces in July in connection with rice variety trials.

Mr. B.D.A. Beck, Botanist, returned from leave in December and spent three months at the Regional Research Station, Samaru.

Mr. F.A. Squire, Principal Research Officer (Entomology), toured the Northern and Eastern Regions in November and December. Mr. J.L. Gregory, Entomologist, visited the Northern Region in June and the West African Institute for Oil Palm Research, Benin on several occasions. Mr. K.M. Harris, Entomologist, visited Kano Province in July, the Middle Belt in August and Ibadan headquarters in August and December.

Mr. D.G. Robertson, Plant Pathologist, visited Ilorin in September and November. Mr. P.E. Udeaja, Plant Pathologist, toured the Northern and Eastern Regions in February and March.

Mr. J.A. Marden, Technical Officer, visited the proposed site of the Plant Quarantine Station at Kano in February. Mr. S.G. Jackson, Technical Officer, visited Port Harcourt in August. Mr. M.J. Ekandem, Technical Officer, visited Ilorin in June, the Eastern Region in June, September and February, Lokoja in October and the Federal Rice Research Station in November. Mr. J.K. Olurin, Technical Officer, toured the Eastern Region in September.

Mr. W.A. Porter, Station Manager, visited the Federal Rice Research Station in November.

Dr. C.M. Petrie, Librarian, attended a West African Library Association Conference in Ibadan in March.

Visiting research workers from outside territories included Mr. Nigel Heseltine, F.A.O. Specialist; Mr. B.J. Manistone, Field Research Officer, Dunlop Rubber Co., Malaya; Mr. J.P.F. Sellschop, Department of Agriculture, South Africa; Dr. E. Roberts, West African Rice Research Station, Rokupr; Professor J. McIlroy, Faculty of Agriculture, University College, Ibadan; Messrs. K. Wilson Jones, Colonial Pesticides Research Committee; P.C. Chambers, Agricultural Adviser, Ministry of Agriculture, Northern Region; T.A. Phillips, Director, Ministry of Agriculture, Eastern Region; Dr. J.I. Taylor, Director, Federal Department of Veterinary Research, Vom; Messrs. E.J. Jeffries, Director and S.S. Levi, Principal Research Officer, Federal Institute of Industrial Research; L.A.W. Hayward, Principal Research Officer, West African Stored Products Research Unit; Professor Webb, Department of Zoology; and Professor Sansome and Dr. E. Njoku, Department of Botany, University College, Ibadan; Mm. M. Lozes, J. Sagbdan, M. Nouvogressi and M. Enabi; Professor J. Lebrun, Secretary-General, I.N.E.A.C.; M.F. Hendryckx, Scientific Secretary, C.C.T.A./C.S.A.; Mr. Heptinstall, Secretary, W.A.I.T.S.; Dr. P. Snyder, International Development Services; Mr. H. Irving, Acting Deputy Secretary of Research and Specialist Services, Samaru; Mr. G. Bacs; Dr. S.J. du Plessis, Chief, Division of Plant Control and Quarantine, Pretoria; and Mr. D.L. Downie, Deputy Director, W.A.I.F.O.R., Benin.

Other visitors to the Department included M.J.H. Michel, French Consul, Lagos; Dr. F. Milam, American Embassy, Monrovia; Mr. F.G. Selby, Federal Public Service Commission; and Mr. Emerson and Mr. Berryhill, International Co-operation Administration.

ACKNOWLEDGMENTS

Once again, it is a pleasure to record our grateful appreciation of the continued interest and helpful assistance received from the Commonwealth Agricultural Bureaux, and the Rothamsted Experimental Station, the East Malling Research Station and the Long Ashton Agricultural and Horticultural Research Station.

J.M. WATERSTON

DIRECTOR OF AGRICULTURAL RESEARCH

22nd May, 1959.

PROGRESS IN RESEARCH
SOIL FERTILITY INVESTIGATION

Soil Organic Matter (J.A.R. Bates)

The loss of weight on ignition of an oven dry sample has often been used as a criterion of the organic matter content of soils, but it has been found that the results obtained by this method for local soils give considerable discrepancies when compared with the Walkley-Black carbon analysis; the error is greatest for the clay fraction in the forest soil which has been investigated. The 'humic' and 'fulvic' fractions have been investigated more thoroughly. About 15% of the humic acids are soluble in alcohol-benzene. The fulvic acid complex has been separated by Forsythe's technique (absorption on to a charcoal pad) and four main fractions obtained: free amino acids and simple sugars, phenolic glucosides, a polysaccharide complex and a fourth fraction of unknown constitution. The phenolic glucosides occur mainly in the plant residues and coarse silt.

Oxidation of the soil fractions with 6% hydrogen peroxide at 68°C has shown large differences in the susceptibility of the organic matter to the treatment. Twenty-seven percent of the carbon and twenty percent of the nitrogen in the coarse plant residues survive the oxidation, the corresponding figure for the clay fraction are C, 6%; N, 30%. The probable explanation is that the nitrogen in the clay fraction is in the form of fixed ammonia.

Fractionation of Soil Phosphorus (Mrs. T.C.N. Baker)

The work on this has continued, ammonium fluoride is being used in place of sodium bicarbonate as an extractant; 0.5 M ammonium fluoride (ph 7) is shaken with the soil sample for 1 hour (extractant: soil = 50:1). This method removes 14.7 p.p.m. P from forest soil and 7.1 p.p.m. P from cropped soil as compared with 10 p.p.m. P and 4.5 p.p.m. P respectively when sodium bicarbonate is used. Organic phosphorus has been measured by the ignition method, i.e., measurement of the increase in phosphorus extracted by 0.2 N sulphuric acid after ignition at 550°C for one hour. The forest soil is rich in organic phosphorus - about 294 p.p.m. in the top-soil, whereas the cropped soil contains only 62 p.p.m.

Total and organic phosphorus are high throughout the profile in a forest pit, especially so in the top-soil. The amount of total phosphorus below the surface soil is mainly a reflection of the total inorganic phosphorus present; this varies between 100 - 225 p.p.m. with a maximum in the 7 - 20" layer. The forest soil contains large amounts of iron oxide concretions; in the 7 - 12" and 40 - 50" layers the concretions account for 42% and 41% respectively of the total soil. These concretions are very rich in phosphorus, averaging 586 p.p.m.

The phosphorus content in the different soil fractions varies considerably, the clay fraction has the highest phosphorus content and the coarse sand the lowest. The amounts of 'available' phosphorus in the sand fraction are strikingly low. The coarse and fine plant residues are high in acetic acid soluble phosphorus, but Truog's reagent, ammonium fluoride and sodium hydroxide remove appreciably less. All four reagents remove comparable amounts from coarse silt and silt, but for clay the pH of the extractant appears to be important - thus acetic acid removes only 15 p.p.m. whereas sodium hydroxide removes 251 p.p.m.

Crop Nutrition (R. Spencer)

Work on soils and crop nutrition began in November 1958 with the arrival of the Plant Physiologist and the Soil Chemist. Since then the experimental work has been confined to testing the various techniques to be used in future work and to obtaining standards.

The nutrient status of plants as affected by the available nutrients in the soil, applied fertilizers and the interaction of the elements within the soil is to be studied. The nutrient status of the plant will be determined by leaf analysis and, at the same time, soil samples will be taken to

determine possible correlations between nutrient levels in the soil and in the plant.

Sand and water culture methods will be used to observe deficiency symptoms in various crops and leaf analyses will be carried out under deficiency optimum and toxicity levels of nutrient availability.

The preliminary work has been carried out with these main projects in mind. Standard curves for various elements have been prepared from which a quantitative measure of the nutrient level in plant extracts can be obtained. Nutrient stock solutions have been prepared on a milligram equivalent per litre basis. When facilities become available, culture experiments will begin.

IMPROVEMENT OF FOOD CROPS

Cassava (B.D.A. Beck)

The collection and classification of Nigerian cassava varieties was continued. One hundred and ninety-four interspecies hybrid clones derived from the 1956 Amani seed acquisitions were added to the collection. Seed acquisitions of Manihot glaziovii and M. utilissima from India and cuttings of M. heptaphylla from Kew have been established in the collection. The highest yielding 1957 and 1958 acquisitions have been used in the current series of regional trials.

Cassava Regional Trials

The design of the field trials in the Regions has been modified to include information on the effect of length of growing period on the yield of cassava. The 1958 trials are of two years' duration and have been planted at the following centres: Ilora Crop Research Station; Agege Experimental Farm; Akure School Farm; the West African Institute for Oil Palm Research at Benin; Ilorin Farm Centre; Osara Farm Centre; the Federal Rice Research Station at Badeggi; and the Federal Department of Veterinary Research at Vom. The objects of these trials are to select the highest yielding variety for each centre; to examine the effect of length of growing period on yield; to compare the yield of the varieties selected at Moor Plantation with the best local types; to observe the reaction of the Moor Plantation varieties to locally occurring strains of cassava mosaic virus; and to determine the interactions between variety and locality. Each trial contains the four most promising Moor Plantation selections and the highest yielding variety in the area. The trials are of a standard six-replication randomised block design replicated at each centre. The variety plots are split three times for length of growing period. The sub-plots will be harvested after twelve, eighteen and twenty-four months' growth.

To provide preliminary information on the performance of Moor Plantation selections in the Eastern Region, an 11-variety incomplete block trial was planted at the Eastern Region Research Station, Umudike and replicated at the Government Farm at Abak.

Following the results from the variety trial at Effurun Government Farm in 1957-58, when the Moor Plantation varieties showed no superiority over the best local type, observation plots of nine selected Moor Plantation varieties of contrasting growth habit were planted at Effurun in 1958. These plots will provide information on the growth of cassava in areas of high rainfall before further statistical trials are planted in the Delta.

The replicate of the 1957-58 trials at Fashola Stock Farm showed a negative correlation between stand count and yield. This was further investigated in a trial planted at the Ilora Crop Research Station to determine the optimum spacing for cassava in the Guinea savannah zone. The trial is a 3-variety, 6-spacing, randomised block design with four replications.

The dry season cultivation of cassava in the fadamas of the Northern Region presents special problems, as the growing period is limited to the interval between successive rice crops and suitable varieties must therefore grow and mature rapidly. Selections from the 1955 series of hybrids and variety 53101 are compared with the highest yielding local variety in a six-replication randomised block trial on the fadama at the Federal Rice Research Station, Badeggi, to select varieties suitable for this type of cultivation.

Planting of the trials in the Regions was delayed by the late onset of the rains in 1958 and the results will be published in a later report.

CASSAVA TRIALS ON MOOR PLANTATION

Two progeny trials of selections from the 1955 series of hybrids were planted. The trials contained selections from the progenies of varieties 37065 and 42074. These selections are now in the third stage of multiplication. Selection from the cassava collection was continued in a 21-variety incomplete Latin square design with five replications.

Observation plots of variety 55123 were harvested in October after eighteen months' growth. A sample of 342 plants gave a mean yield of 13.6 lb per plant, equivalent to 22 tons per acre. A second sample, taken when the plants were 25 months' old, gave a mean yield of 21.1 lb per plant which is equivalent to 34.2 tons per acre. This is the highest yield of cassava recorded in Nigeria. The highest yielding plant in the sample produced 123 lb of tubers. The mean dry matter content of tubers from this ample was 30.2 per cent. Reports from purchasers of this variety state that it can be made into good garri.

The effect of length of growing period on the yield of cassava was investigated in a trial of 21 months' duration. Plants were harvested at three monthly intervals and there was a highly significant increase in yield with increasing length of growing period. Variety 53101 matured most rapidly and after nine months' growth gave a significantly greater yield than any other variety in the trial. The yield increases and growth of varieties 37065 and 43083 from nine to 21 months were more rapid than those of 53101 and at the end of the experiment there was no significant difference in yield between these three varieties. Their yield was equivalent to 21 tons per acre. There was no significant increase in the tuber number of any of the varieties in trial and it remained constant after the first six months growth. Thus, increases in yield with age in cassava are caused by addition to tubers initiated in the first six months' growth rather than by the continuous formation of new tubers.

CASSAVA HYBRIDISATION

The object of the 1958 breeding programme was to assess the genetic potential of the interspecies hybrids produced during 1957. Those hybrids selected for high yield have been self-pollinated, crossed with high and low yielding cassava varieties and inter-crossed to examine the segregation of high-yielding individuals in the progeny. Interspecies hybrids selected for mosaic resistance have been selfed, crossed with cassava varieties showing mild and severe symptoms of mosaic and intercrossed to examine the segregation of mosaic resistance in the progeny. Ten thousand five hundred controlled pollinations produced 7,300 seeds.

The production of F_1 *M. utilissima* x *M. glaziovii* interspecies hybrids was continued. Eleven per cent success was obtained over all pollination in these crosses, giving 8 per cent of the expected maximum number of seeds. *M. melanobasis* is reported to have a very high protein content in the tubers and, to investigate the inheritance of this character, F_1 *M. melanobasis* x *M. utilissima* hybrids were produced. Thirty-seven per cent success was obtained from all pollinations in this cross, which was better than the 34 per cent success obtained with *M. utilissima* x *M. utilissima* crosses during the same period. The seed yield in both sets of crosses was 28 per cent of the theoretical maximum.

The 1956 and 1957 series of hybrids were harvested during 1958; they consist of the progeny of six varieties of cassava crossed in all possible combinations to give 36 families. Variety 53101 was the highest yielding

of the parent varieties and its progeny were the highest yielding families. Eighty-six per cent of the hybrids selected for further multiplication were the progeny of 53101. The highest yielding hybrid in this population gave a yield equivalent to 34 tons per acre after eighteen months' growth. Variety 42074 showed the least severe mosaic symptons of the parents and its progeny had the lowest average score for severity of mosaic.

Interspecies hybrids in the first stage of multiplication showed a very high degree of resistance to cassava mosaic virus. Variety 58308 has remained free from mosaic symptoms after three years' exposure to infection in the field. This variety was obtained from a M. glaziovii x M. utilissima cross and has been used in the 1957 breeding programme. Other varieties have shown slight mosaic symptoms early in their growth but these faded as the plants reached maturity. This irregular and occasional expression of mosaic symptoms, particularly in hybrids derived from M. glaziovii, has been noted by workers in East Africa.

The hybrids were assayed for dry matter content of the tubers. The average dry matter content of all the hybrids was 30.4 per cent of the fresh weight. Sexually fertile hybrids with a dry matter content of 40.0 per cent and more were retained for further examination and for breeding.

OBSERVATIONS ON CASSAVA MOSAIC

The system of classification of the leaf mosaic symptoms of infection with cassava mosaic virus, developed during 1958, has been used in a scoring system to estimate the severity of mosaic in the hybrid populations described above. Plants of variety 43083 fall clearly into two classes on this system and there is a significant difference between the mean yield per plant of the two classes.

The results of experiments at the Northern Region Research Station, Samaru showed that primary infection with cassava mosaic virus caused highly significant decreases in yield in two varieties of cassava after eight months' growth. A third variety, Samaru Dan Warri, showed no significant decrease in yield and appears to be truly tolerant to cassava mosaic virus.

Kola (B.D.A. Beck)

Individual tree yield recording was continued in the population of F1 hybrid kola on Moor Plantation. As in previous years, the hybrid trees grown from white nuts, produced by crossing two white nut parents, were the lowest yielding group and hybrids grown from red nuts, produced by crossing pink and red nut trees, were the highest yielding group. The latter hybrids gave a mean yield of 373 nuts per tree during 1958.

The study of the mechanism of inheritance of cotyledon colour in Cola nitida was continued. F1 hybrid trees grown from pink nuts obtained by cross or self-pollinating pink nut parents were selfed and back-crossed to their parent trees. As in 1957-58, these trees bred true for pink cotyledon colour. Self-pollinations of the pink nut parents demonstrated that the progeny of these also breed true for pink cotyledon colour.

In 1957-58, red nut hybrid trees obtained by crossing two red nut parents were reported to be self-sterile. This investigation was continued; 601 self-pollinations have now been carried out on this group of hybrids and no fruit set has been recorded. Red nuts can be obtained from crossing red x white nut parents, red x pink nut parents and red x red nut parents, and, in an examination of the self-pollinations carried out in these groups of hybrids, the red nut trees derived from crossing pink x red nut parents were shown to possess the greatest degree of self-compatibility.

The data from self-pollinations in the red nut hybrids derived from red x red nut parents suggest that these trees are self-incompatible; three of the self-incompatible trees were successfully cross-pollinated in 1958 and bred true for red colour of the cotyledons.

Coffee (B.D.A. Beck)

Yield recording of individual trees was continued. The yields were considerably higher than in 1957-58. The Coffee canephora variety "Gold Coast robusta" produced the highest yield, giving 4,500 lb fresh cherry per acre, an average of 17.7 lb. per tree. The yields are given in Table 2.

Yams (A. W. Waitt)

Fifteen varieties of D. alata received from the Fiji Islands, now released from quarantine, will be placed in the collection and multiplication plots.

Three variety trials, designed as randomised blocks with four replications, were carried out in 1958. Fourteen varieties of white yam (D. rotundata) and seven each of water yam (D. alata) and yellow yam (D. cayenensis) were used. The yields of all species were approximately one third less than those of 1957 and this is attributed to the rainfall occurring in June instead of July, followed by a long dry spell. Of the varieties of white yam placed under trial none gave a higher yield than the best local variety. The best yielding variety of yellow yam came from the Eastern Region and the best variety of water yam from the Northern Region. Germination counts were carried out and analysis of the results showed significant differences between varieties within a species.

Setts from yam tubers give highly variable germinations, which is undesirable from the point of view of the farmer and the research worker. Experiments are therefore being undertaken to find some means of ensuring a more reliable germination of planted setts. In November harvested tubers of variety Iyawo (D. rotundata) were placed under three treatments; in treatments A and B the tubers were cut into normal-sized planting setts and placed in two pits. Pit A was not mulched and pit B was mulched after the soil was replaced; and in treatment C the tubers were tied up in the yam barn under normal storage conditions. In March the setts from A and B were planted at the same time as setts cut from tubers from treatment C. The layout was a randomised block with eight replications. Germination counts and yield observations were made. Statistical analysis of the germination counts showed that treatments A and B were significantly better than treatment C. However, analyses of yields showed that normal storage was superior to the storage of setts in a pit covered with mulch but not to the storage of setts in a pit without mulch. The results show that by pre-germinating the setts an increase in the number of stands and in yield can be obtained. It is of interest to note that B gave a higher germination count than C, yet the yield of C was greater than B. This may be explained by the fact that on opening pit B the sprouts were long - longer than in pit A - but, after planting, the longer sprouts suffered from adverse weather conditions more severely than those of either treatment A or C.

A staking trial was designed to compare the effect on yield of 10-ft. staking against normal 6-ft. staking on four species of yam - D. rotundata, D. cayenensis, D. dumetorum (cluster yam), and D. alata. The design was a randomised block with split plots. Observations were made on germination and yield. The analysis of variance for germination counts and yield showed significant differences between species but treatment significance was found only in D. alata where tall staking gave a higher yield than normal staking.

In 1957 a growth trial was carried out in which samples were taken at regular intervals during the growing season from plots of D. alata, D. dumetorum, D. cayenensis and D. rotundata. The results suggested that there was a good correlation between fresh weight of vine and fresh weight of tuber until the vine began to die back when there was a negative correlation. The mean monthly rainfall figures were plotted against the vine and tuber weights. It was apparent that with increased rainfall the average fresh weight of vines increased although with a time lag which varied with the species. Similar results were obtained in 1958 with a

very marked seasonal effect due to the rainfall peak being in June and not in July as in 1957. This affected the final yields in all species and in particular the growth curves of the species with a short growing season such as D. alata and D. rotundata. These experiments suggest the need for further study on the relative growth rates of varieties under different climate conditions.

The tubers of yam when harvested exhibit a definite rest period. The duration of this dormancy varies between and within species. Research carried out at the Imperial College of Tropical Agriculture, Trinidad has shown that ethylene chlorohydrin used as a dip can break this rest period in the tubers of D. alata var. Lisbon. In the past two years pilot experiments have been carried out on Moor Planation to investigate the use of eight different chemicals in breaking the dormancy of the yam tuber. The results show that there is a slight increase in total germination in favour of sodium thiocyanate and gibberellic acid over other treatments.

Dry matter and moisture content determinations have been carried out on 60 varieties of D. rotundata, 14 varieties of D. alata and 18 varieties of D. cayenensis. D. cayenensis gave the highest mean dry matter content, followed by D. rotundata, then D. alata.

Studies have continued on the seeds of D. rotundata and D. dumetorum and it is now possible to obtain germination percentages of over 60.

Sweet Potatoes (A. W. Waitt)

Material sent from the South-east Pacific has now been released from quarantine and is being multiplied for trial purposes.

The study of cross-and self-incompatibility has continued between eleven parent varieties and six open-cross progeny lines. A total of 509 self-pollinations and 348 cross-and reciprocal cross-polinations were carried out. Results from these pollinations suggest complete self-incompatibility in all varieties and cross-incompatibility between certain varieties.

Palatability tests carried out this year show that the eighteen parent varieties contained in the collection are of the dry flesh type.

A planting trial with the variety French Guinea was carried out to study the effect of spacing and time of harvesting on the yield and percentage of ware tubers. The spacings used were 1½ ft. on 3-ft. ridges, 1 ft. on 3-ft. ridges, and 8 in. on 4-ft. ridges. These distances gave plant populations of 9,680, 14,520 and 16,335 plants to the acre respectively. Plots were harvested at 120, 140 and 160 days from planting.

The results show that the length of the growing period should be not less than 160 days and there is a possibility of increasing the yield by extending the time from planting. The best spacing distance was found to be 8 inches on 4-ft. ridges.

Cocoyams (A. W. Waitt)

The varieties in the collection and new acquisitions are being multiplied with a view to carrying out agronomic trials. The study on varietal characteristics is continuing.

Rice

METEOROLOGY

Rainfall at Badeggi in May and June although slightly below average was not sufficiently so to affect the successful establishment of the experimental material. Total rainfall for the year was 10 inches below the average of 48.65 in. Meteorological data are tabulated in Table 6.

During July there was a prolonged drought throughout the riverain Provinces, followed in August by widespread symptoms of 'dry-leaf disease'. An orange-yellow discoloration of the leaf blade, which spread backwards from the tip, was accompanied by purpling of the leaf margins and a poorly developed secondary root system. No fungal or insect pathogen was observed and the symptoms were too widely dispersed to be attributable to a nutrient deficiency. In September when rainfall was normal the symptoms largely disappeared but yields from varietal trials were below average.

EXPERIMENTAL FIELDS

The average coefficient of variability of all field trials at Badeggi was, as in 1957, very high (25.5 per cent) despite further levelling of the experimental paddies. Although soil heterogeneity accounted for part of the error factor it is evident that even the normal supply of supplementary irrigation water to the experimental fields necessitates a degree of irrigation control not yet attained. In 1958 the situation was intensified by the abnormally low rainfall.

PLANT BREEDING

Breeding projects are related to the distinct requirements of four main ecological zones. Wherever possible, however, varieties released are being confined to a single grain type within each well-defined area of production in order that milling quality may be improved. Progress is reviewed below under ecological zone headings.

NATURALLY INUNDATED LOWLANDS

The cultivation of the indigenous, commercially less acceptable, red rice varieties of Oryza glaberrima is now restricted to the deep-flooding Northern fadamas. The aim of the several projects is the successful introduction of high-yielding, non-shattering white-grained varieties adapted to this environment.

Agrotaxonomy of Oryza glaberrima:- The study of the indigenous collection to obtain information upon which to base the inter-species hybridisation programme between Oryza glaberrima and O. sativa was continued and the collection enlarged. Herbarium specimens of a large part of the collection were examined at Kew and the complex taxonomic position reviewed. As a result a modified form of the classification proposed by Portères (J. Agric. trop., 1956, 3, pp. 821-856) has been adopted and a key for field use has been prepared for publication.

The O. glaberrima collection was replicated at both Badeggi and Birnin Kebbi in 1958. At Badeggi the collection has been classified into upland and deep, medium and shallow swamp varieties on the basis of growth habit under controlled conditions. At Birnin Kebbi the collection was deliberately subjected to deep swamp conditions in order to determine varietal differences in growth response to increasing flood depth. From the results it is clear that all the 28 swamp varieties can withstand a flood depth of four feet. Twelve varieties survived depths of 4ft. 6 in. and four survived depths exceeding 5ft. Varietal differences in response demonstrated the soundness of the original method of classification. The yield figures were very variable indicating the necessity for comparative yield trials including varieties of similar depth tolerance.

Interspecies hybridisation:- The object of this investigation is to produce hybrids combining the floating habit and flood resistance of the O. glaberrima varieties with the white caryopsis and non-deciduous spikelet of the O. sativa varieties. In 1958 the 30 seeds obtained from five hundred crosses made in 1957 proved non-viable. In 1958 improvements in technique resulted in a higher average percentage seed set (14 per cent) but low cross compatibility was still evident. The O. glaberrima variety was always used as the pollen parent because the stigmas of the O. glaberrima varieties used did not retract into the glumes after artificially induced opening of the spikelet. One hundred and ninety-four seeds were produced from 1370 crosses.

Inter-varietal trials:- Eight floating varieties of O. sativa, observed to be suitable for the inundated areas, were compared in a trial at Badeggi. The varieties Tisei, Nan Rung F6, Mbagboli and Mali Ong were not significantly lower yielding than the present standard floating variety Indo-China 53 (17.4 cwt/acre). In a similar trial in 1957 Mbagboli significantly outyielded Indo China 53. Mali Ong is noteworthy for possessing the popular long grain type.

In a non-statistical replication of this material under deep-flooding conditions (greater than 5ft. 6 in.) at Birnin Kebbi, the yield figures indicate that the varieties Indo-China 53 (14.3 cwt/acre) and Mbagboli (12.6 cwt/acre) can outyield the local deep water variety Babban Fari (9.66 cwt/acre). The yield figures given exclude that percentage of the harvested weight attributable to the volunteer crop of O. glaberrima which, contrary to expectation, never exceeded 10 per cent. This is the first recorded success of varieties of O. sativa in these conditions and may be attributed to the use of large observation plots.

A marked lack of response to increasing flood depth was evident in a non-statistical replication of a group of 21 shallow swamp varieties (including BG 79) at Birnin Kebbi. Although they were subjected to maximum flood depths of 48 inches, in no case did the yield of any of these varieties exceed 33 per cent of that of the O. glaberrima control. Late varieties were adversely affected by drought.

Intra-varietal trials:- No significant improvement in the present vigorous stock of Indo China 53 was observed in a trial of three re-selections of that variety at Badeggi.

Milling quality:- The poor milling quality of red rice is one reason for its lower commercial value. Preliminary studies in 1958 indicated that the poor milling quality is largely due to the comparatively long time taken to remove the very smooth husk of this species in the single-stage mills now in use. Removal of the husk and bran in two separate operations in laboratory scale milling considerably reduced the percentage of broken grain and permitted 99 per cent removal of the red bran.

NON-INUNDATED IRRIGABLE LOWLANDS

The main aim of the project so far has been to introduce a higher yielding main crop variety to replace BG 79, dominant alike in the rainfed irrigable valleys of the North and the rainfed basin swamps of the East. It is now apparent that there is a need for earlier maturing varieties to reduce the drought hazard in the non-irrigated areas in the North.

Inter-varietal trials:- Two trials of longer duration varieties, suitable for irrigation schemes, were repeated for the third successive year at Badeggi.

Kav 12, a seven-month variety, often sold as the popular Geb 24, was again shown to be significantly higher yielding than India Palil 82, Anak Didek, Kontor and Radin China 4. The last of these has just been released by the West African Rice Research Station but appears unsuitable for Nigerian conditions.

Bolo 108 and Toma 112 - both 6-month varieties with the popular long grain - were again shown to be capable of yields equal to, or significantly higher than, that of Ngasein 57 which possesses the unpopular broad grain type. Ngasein 57 was withdrawn from multiplication in 1958 and the decision to replace the popular pink-grained Toma 112 by Bolo 108 awaits milling and cooking tests.

The late main crop ($5\frac{1}{2}$-month) trial, including Geb 24 as the control, was replicated for the third year at Badeggi and the second year at three Regional centres. Results from Yola and Pateggi confirm the superiority, noted in the previous two years at Shendam, of D99 and Lead 35 over Geb 24.

Since it is now clear that the preference for Geb 24 is based on palatability rather than yield this trial is to be discontinued and the acceptability of D 99 and Lead 35 examined.

The main (5-month) crop variety trial, including BG 79 as the control, was replicated for the third year at Badeggi and the second year at nine Regional centres. Results from Badeggi, Shendam, Zonkwa, Yola, Pateggi and Bauchi in the Northern Region indicate, as in 1956 and 1957, the superiority of Mas D52/37 and D 114 to BG 79 on alluvial soils. As in previous years, the time-fixed variety Mas exhibited its superiority only when planted early and when there was an adequate water supply at the end of the season. The yields varied considerably. For example, Mas yielded 24.1 cwt/acre at Yola and only 7.6 cwt/acre at Zonkwa, but retained its superiority to BG 79 in both trials. This trial will be repeated for a third year in the Regional centres in 1959 and the comparative milling and cooking qualities of Mas D 114 and D52/37 assessed before either or both of these is released.

At Badeggi a trial of a further fourteen varieties, introduced to replace BG 79, revealed only one variety, Caloro 2 (17.2 cwt/acre), which significantly outyielded BG 79.

In anticipation of the expected demand for earlier maturing varieties two trials were commenced in 1958 at Badeggi. BG 79 was used as the control in both since the acceptance of early varieties will depend upon the farmer's ability to grow them without loss of income.

Of six four-month varieties, three (No.32, Makalioka 803 and Early Dissi) were not significantly lower yielding than BG 79. Only two three-month varieties (Taichu 65 and MTU-6) out of twelve in the trial did not yield significantly less than BG 79. Both have a broad grain and will serve as parents in the 1959 hybridisation programme to combine early maturation, high yield and long grain.

Intra-varietal trials:- No significant differences were observed between four Station re-selections of the 7-month variety Kav 12.

Six 5-month D selections, issued by British Guiana, in trials at Badeggi for the third successive year, showed that D 99 and D 114 gave significantly higher yields than D 85/42 and D 54/42. These results bear out the consistently good performance of D 114 in the BG 79 replacement trial in the Regions. A trial of 24 Station selections from seven main crop varieties revealed that only five selections significantly outyielded the control BG 79. Three were derived from D 99 and two from Mas, and they reflected the proved superiority of their parent varieties to BG 79. Thirteen selections are to be carried forward into 1959.

For the third successive year four West African Rice Research Station re-selections of BG 79 did not give significantly greater yields than the standard variety BG 79.

These results confirm that little scope exists for re-selection within the established varieties of Nigeria, all derived from single plant selections

RAINFED UPLANDS

A replacement with higher yield is required for the short duration glutinous Agbede grown on the permeable soils of cleared rain forest in the Western Region and a vitreous grained variety for impermeable, temporarily water-logged soils in the North.

Inter-varietal trials:- Two trials were established at Agege and Akure in the Western Region. The result from Akure indicates that the old established varieties Agbede and Oshodi significantly outyield Bikom, introduced from the Southern Cameroons. There were no significant differences between upland varieties at Agege where the trial was subject to a severe drought in mid-season. The 3-month duration upland varieties were severely affected

before flowering and in these cases the later-maturing swamp variety BG 79 significantly outyielded them all.

At Akure the trial was planted one month later and no yield was obtained from the late-maturing BG 79 owing to drought at the end of the season.

Though further repetition of these trials in normal seasons is essential it will be necessary to include 3-month dual-purpose swamp varieties for greater drought resistance in areas subject to a pronounced short dry season.

Observation Collection:- Summarised information on Oryza sativa varieties originally introduced in 1954, 1955 and 1956 was transferred to punched cards. Of these varieties, those not already rejected will be transferred to a maintenance collection in 1959 for comparison with more recent introductions.

Sixty-six varieties were introduced in 1958 including 28 upland, 18 swamp and 19 floating varieties, bringing the total collection to 236.

INTRA-SPECIES HYBRIDISATION

A limited programme with the object of examining the inheritance of sensitivity to photoperiod was undertaken. The non-photoperiod sensitive indica variety Mas was crossed with photoperiod sensitive indica varieties. The results may be due to the increasing skill achieved by the assistants in a difficult crossing technique since the percentage seed set rose from 12.1 per cent at the beginning to 83.6 per cent at the end of the season. From 533 crosses 153 seed were set.

SEED MULTIPLICATION

More than 600 lb of BG 79 were produced to supply stage 2 centres in the North, East and West. In addition, seed of Geb 24/37, Toma 112 and Kav 12 was supplied to the Northern Region and seed of Agbede to the Western Region. All stage 1 seed distributed was 100 per cent pure and free from red grain.

GRAIN PREFERENCE SURVEY

This survey (to be published as a technical report) was carried out to determine to what extent preferences for the few established varieties in Nigeria had developed and whether preferences differed amongst producers, millers and consumers. It appears that the acceptability of variety depends finally on consumer preference which was shown to be overwhelmingly in favour of the long grain type typified by BG 79. The information obtained will serve as a guide in the introduction and hybridisation programmes.

NUTRITIONAL ANALYSIS OF RICE

The wisdom of attempting to replace the indigenous red rice varieties by white rice has been questioned on the supposed greater nutrient value of red rice.

Two pairs of samples, each consisting of one variety of O. sativa and one of O. glaberrima, were submitted to the Tropical Products Institute, London. Both the red rice samples exhibited a higher nicotinic acid, calcium, iron and phosphorus content than the white rice samples, though thiamine content was lower in the red rice samples. The protein content in both types varied widely between two varieties of the same species. It is evident that variation within the species may well be as great as variation between the two species. Multiple samples are to be sent to the Tropical Institute in 1959 for more thorough examination.

Agronomy

CULTURAL METHOD TRIALS

The present objective is to establish the optimum factors in each traditional method of rice cultivation under Nigerian conditions before comparing the productivity of the various methods.

In 1957 three successive trials established the optimum unit area per stand for transplanted rice as 0.56 sq. ft. The influence of the number of seedlings per stand was not significant. In 1958 an identical trial with direct-seeded rice again indicated that close spacing gave a significantly higher yield, but that increasing the seed population per stand also gave significant increases in yield. This may be attributed to the selective elimination of weaker seedlings by competition. There was no interaction between stand population and spacing, and no correlation between tillers per stand and yield.

In a trial comparing four rates of seed broadcasting no significant yield differences were observed between 35, 60, 85 and 110 lb seed/acre. Normal rates now in use in the Northern Region vary between 60 and 80 lb seed/acre.

A trial designed to demonstrate yield responses to three fungicidal seed dressings indicated no significant differences between Fernasan A, Fernasan D, Dieldrin B and the control. As in previous years' experiments with mercurial preparations, the greatest yield occurred when an insecticide was used.

HERBICIDES

Preliminary observations on the effectiveness of various herbicides in controlling weed growth in transplanted and direct-seeded rice were not very encouraging. In no case was the need for subsequent hand weeding eliminated and the yield figures indicated no difference between sprayed and hand-weeded plots.

With irrigated transplanted rice the results indicated that CP-18-15 (PHPBA and TCB), applied one week after wet transplanting, at either 4 or 6 pints/acre, effected the greatest weed control without decreasing the establishment and vigour of the rice. Fernoxone (2-4-D), applied one week after transplanting at 6 lb/acre, was the next most effective. Phenoxylene (MCPA) caused a significant reduction in rice establishment but effected no weed control.

A further observation with direct-seeded rice indicated that both Fernoxone (2-4-D) and Simazin (TCB) had a deleterious effect upon dry-seeded germinating rice at all strengths capable of effective weed control. Trioxone-Fernesta (2-4-5-T) appeared to effect some degree (60 per cent of total vegetative cover) of weed control even when seeding took place two weeks after spraying at 6 and $4\frac{1}{2}$ pints/acre.

Both Fernoxone (2-4-D) and Simazin (TCB) at 4 lb/Acre were effective (90 per cent of total vegetative cover) when sprayed on to dry ground immediately after final cultivation. Effective control was maintained by spraying every four weeks but was lost at longer spraying intervals. In both cases there was no reduction of rice establishment when transplanting took place into evenly irrigated plots one week after spraying.

The principal weeds at Badeggi are monocotyledons. Although none of the herbicides controlled perennial wild rice (O. barthii), all Cyperus species and the dominant grasses including Eragrostis tremula, Eleonorus sp., Digitaria terrata and Panicum longijubatum were controlled. Statistical trials will be started in 1959.

FERTILIZER TRIALS

All fertilizer trials were sited on the alluvial soils of the Edozhigi Irrigation Scheme. On Badeggi series sandy clay, the dominant soil type, a significant yield response to all levels of nitrogen and no response to, or interaction with, phosphate was obtained for the third successive year. Ammonium sulphate at 4 cwt/acre gave a significantly higher yield than 2 cwt/acre (29.7 cwt/acre and 25.2 cwt/acre respectively; control 18.9 cwt/acre).

On Gbagigi series fresh sandy alluvium a yield response to ammonium sulphate was obtained but no significant difference was observed between the responses to rates of 3 and 6 cwt/acre (19.4 cwt/acre and 18.4 cwt/acre respectively; control 12.7 cwt/acre). There was no response to, or interaction with, phosphate.

No yield response to either ammonium sulphate or phosphate was obtained on Edozhigi series silty clay, a very fertile soil. The average yield was 30.7 cwt/acre.

On Mawogi series clayey sand no yield response was obtained to nitrogenous or phosphate fertilizer. This is an isolated soil series suffering from impeded drainage and the rapid development of toxic concentrations of ferrous compounds during the rains. The average trial yield was 20.7 cwt/acre.

CONTROL OF PLANT DISEASES AND PESTS

Cassava Mosaic Virus (S. R. Chant)

Studies have been continued on the spread of the virus in the field in relation to the level of population of the white-fly vector. Attempts have been made to isolate possible strains from the cassava mosaic virus complex. However, no success has been achieved even with single insect transfers.

Cowpea Mosaic Virus (S. R. Chant)

Considerable time has been devoted to this project. The two major aspects of the problem - the nature, physical properties and symptomatology of the viruses and the effect of the viruses in the field - have been investigated concurrently.

NATURE OF THE VIRUSES

It has already been established by Lister and Thresh (Nature, 1955, vol. 175, p. 1047) that a strain of tobacco mosaic virus (TMV) affects cowpeas and Bengal beans at Moor Plantation; this virus was again isolated in April 1958 from these two hosts.

In cowpea the TMV strain was causing only a mild mottling of the leaf and not a mosaic symptom. However, it was noted that many of the cowpeas growing in the Western Region were affected more severely by a virus causing a severe yellow mosaic of the leaves. This virus was isolated and found to have quite distinct properties from the TMV strain and in fact from any other virus hitherto described in cowpeas. The name of "cowpea yellow mosaic" has been provisionally assigned to this virus.

HOST RANGE

The TMV strain has been found in the field naturally infecting Vigna unguiculata, Mucuna aterrima, Canavalia ensiformis, Crotalaria juncea and Centrosema sp.. In the greenhouse, systemic symptoms have been produced on Phaseolus vulgaris, Doliches lablab and Physalis peruviana in addition to the above hosts. Local lesions have been produced on the inoculated leaves of Nicotiana glutinosa. An unusual feature of this strain is that it first causes local lesions on inoculated leaves of tobacco (Nicotiana tabacum) followed by a systemic mosaic.

No reaction has been observed on Zinnia sp., Capsicum frutescens, Pueraria sp., Lycopersicum esculentum, Arachis hypogaea or Glycine soja.

Cowpea yellow mosaic virus has not been found on any alternate host in the field and in the laboratory systemic symptoms have been produced only mechanically on inoculated cowpea. However, on Phaseolus vulgaris necrotic local lesions are produced and on Mucuna aterrima, in addition to this symptom, systemic lesions appear on leaves produced after inoculation.

PHYSICAL PROPERTIES OF THE VIRUSES

The TMV strain reacts typically in respect to heat treatment, dilution and retention of infectivity. Cowpea yellow mosaic virus has been found to have the following properties:

Dilution end point $\frac{1}{50000}$

Thermal inactivation point $\frac{1}{10}$ dilution in 10 min. at 54°C

Longevity in vitro 4 days at 25°C
20 days at 4°C
4 days at -15°C

Serological reactions:- An antiserum has been produced with an end point of $\frac{1}{64}$ when tested against purified infective cowpea sap ($\frac{1}{5}$ dilution). A dense granular precipitate of the somatic type was obtained, which suggests that cowpea yellow mosaic virus may have spherical particles.

INSECT TRANSMISSION

It has been established that both viruses are transmitted by the Galerucid beetle Ootheca mutabilis Sahlb. Laboratory studies have confirmed that cowpea yellow mosaic virus is probably carried only on the mouth parts of the beetle. Infection passes off rapidly (within 48 hours) when the vectors are serially transferred on healthy seedlings. In field experiments carried out in collaboration with the Senior Botanist of the Western Region Ministry of Agriculture and Natural Resources, it has been shown that seed treatment with "Thimet" (a systemic insecticide seed dressing) in no way affects the population of the beetles in the crop or the spread of the virus, and that close spacing of plants (6 inches on 2-foot ridges) results in significantly less infection than wide spacing (2 feet on 4-foot ridges).

EFFECT OF THE VIRUSES ON THE PLANT

Field experiments have shown conclusively that, when inoculated in the cotyledon stage with cowpea yellow mosaic virus and the cowpea strain of TMV, the yield of the variety Dr. Saunders' Upright is reduced by 70% and 55% respectively. Time of infection in the field is an important factor. Early infection results in less production of leaf and a lower yield. This lower yield is related to a suppression of flower development by the viruses.

Suspected Virus Disease of Yams (D.G. Robertson)

A more detailed investigation of this problem is now in hand. During the last two months of the growing season, work was confined to field observations of the symptom picture of the disease.

Symptoms of the disease have been observed in Dioscorea rotundata, D. cayenensis and D. alata. The symptom expression is most marked in the two former species and takes the form of either vein clearing and interveinal chlorosis, severe chlorosis and green islands, or a faint mottling of light and dark green. The leaves tend to be lanceolate, often distorted and urled.

During the past two years, all attempts at transmitting the disease by mechanical inoculations and the re-growth of tubers have failed. All methods of transmission are to be tested in an attempt to prove the viral nature of the disease.

The Specialist Officer (Nematology) joined the Department in December 1958. He has carried out a preliminary survey of the incidence of nematodes in the roots of Nigerian food crops and this knowledge will provide a basis for the course he is undertaking in the United Kingdom commencing in October 1959.

Plant Quarantine, Moor Plantation (A.G. Bailey, J.A. Marden)

A wooden slatted cocoa quarantine propagating unit has been constructed for budwood from Ghana. This budwood has been budded on to local Amelonado stocks which are used as indicators of swollen shoot virus. Rooted cuttings also have been received from West African Cocoa Research Institute, Tafo, Ghana.

Other plants held in quarantine included Dioscorea esculenta from Fiji, Saccharum officinarum from Barbados, Dioscorea macroura and Xanthosoma lindenii from Scotland and Carica papaya from Florida.

Mealybugs have again been intercepted on cocoa pods imported from Ghana and weevils on a consignment of vegetable seeds from America.

Ninety-three Plant Importation Certificates and 83 Phytosanitary Certificates have been issued.

Plant Quarantine, Calabar (A.O. Bamtefa)

The site for the Plant Quarantine Sub-Station was formally taken over from the Eastern Region Government in May 1958 and has been surveyed and mapped by the Regional Survey Department.

The site was felled and cleared from October to March. The land has been cultivated and contour-bunds have been set up. A soil profile pit has been dug and samples analysed by the Eastern Region Soil Chemist.

Close contact has been maintained with commercial organisations in the Eastern Region who are likely to avail themselves of the Plant Quarantine Service. Phytosanitary Certificates have been issued for the export of rubber budwood to Nyasaland and banana fruits to Holland.

White-Fly Studies (F.A. Squire)

POPULATION STUDIES

Population studies were continued throughout the year and it was clearly seen that there were marked seasonal fluctuations brought about by climatic and biological factors. During the dry season when the white-fly population is at its lowest level, breeding takes place mainly on wild hosts such as Alchornia sp. (Euphorbiaceae) growing in fringing forests and also to some extent on cassava in open fields. Moisture is clearly the limiting factor since the white-fly flourishes on well-watered plants both in the open and in greenhouses, even during the harmattan.

Soon after the first rains there is a great upsurge of population mainly on cassava flushes, but these outbreaks are at first localized in character, becoming more general towards the end of April. At about this time predators appear and cause a remarkable reduction in population although the effect is patchy and of a temporary nature.

Once the rains are well established the predators tend to disappear and the white-fly becomes extremely numerous and widespread and continues to flourish until towards the middle of September when a parasitic fungus appears on the pupae. It spreads rapidly and causes a dramatic collapse of the white-fly population. This phenomenon has been the subject of comment by observers over the past 30 years although its cause does not appear to have been understood. This parasitic fungus persists until the beginning of the dry season and there is no general recovery from its effects until the following rains. The mode of spread of the white-fly in isolated fields has been studied in collaboration with the Plant Pathologist in connection with the transmission of cassava mosaic. Plots of mosaic-free cassava were established early in the year with one infected plant in each plot. The object was to study the spread of the diseas from these foci of infection and relate it to the changing white-fly population pattern. The somewhat unexpected results showed that there is no discernible

outward spread of the disease from the foci of infection. On the contrary it appeared at random all over the plots. The white-fly too, when it appeared, exhibited no orderly pattern of spread inwards from the periphery but appeared at the same time on many parts of the field colonizing the growing tips of groups of plants and soon spreading to almost every stand in the plots. Sampling the white-fly population proved a difficult problem until its peculiar relationship with its cassava host plant was understood.. This is described in the following paragraphs.

HOST-PLANT RELATIONSHIPS

Cassava is the favourite host plant in the dry season and in the early rains. Eggs are laid in great numbers on the youngest leaves near the growing tips and a single young leaf may bear hundreds of eggs. Leaf growth is rapid, the regression of length of digit in mm. (x) on age in days (y) being approximately

1/15 y during the 1st and 2nd days
1/6 y " " 3,4,5th and 6th days
2/5 y " " 7th, 8th and 9th days

By this time the leaf is fully grown and the eggs have all hatched. By the 19th day all the larvae have changed to pupae and by the 25th day nearly all the pupae have hatched and the leaf is now in about the seventh position down the main axis. This bionomic knowledge greatly facilitated white-fly sampling operations on cassava. Irrigated tobacco nurseries are as a rule attacked by white-flies during the early part of the rains but it is noteworthy that although the white-fly is often quite numerous it does not at this state breed on tobacco but continues to multiply on cassava. Later in the rains the white-fly changes over from cassava to tobacco and it is remarkable that even cassava growing next to heavily infested tobacco is often almost entirely free from white-fly.

This alternation may be explained by reference to the secretary trichomes on the undersurface of the tobacco leaves which, being more active in the dry season and early rains, are strongly inimical to the white-fly. During the rains they cease to be such a great danger and, as will be shown later, the white-fly has the means of overcoming them. This hindrance eliminated, tobacco has the obvious advantage of offering better protection from wind and rain and a more copious food supply than cassava. This hypothesis also explains the difficulty many workers have experienced as well as the frequently observed fact that the white-fly prefers the lowest leaves. This has been ascribed to microclimatic factors but is more likely due to the decreased activity of the trichomes on older leaves. It also explains the remarkable absence of white-fly on dry season tobacco in the Northern Region. In this arid climate the trichomes produce a very sticky secretion which would almost certainly engulf any white-fly landing on the underside of the leaf.

The female can, if hard pressed, combat this danger. By scraping the wax off her body and plastering it over the trichomes and leaf surface she can neutralize a small circle about one centimetre in diameter and thus produce a suitable site for oviposition. But the operation is lengthy and laborious and it is easier to find a less inimical host plant. The white patches thus produced are often seen on the underside of tobacco leaves and are a sure indication that breeding is taking place before any larvae are visible. They seldom appear on other host-plants which do not possess secretory trichomes.

Another important cultivated host plant observed during the year was cotton. It is in effect perennial and in the Western Region is often associated with cassava and tobacco. Here the white-fly is nearly always present on cotton but seldom attains striking numbers. It is in the Northern Region in areas where cassava is scarce that its importance as a host plant becomes patent, especially during the dry season when tobacco is not favoured. At such times cotton is often heavily infested with white-fly.

In the Middle Belt, in Ilorin Province another important host plant has been observed. This is Capsicum frutescens, a commercial crop very extensively cultivated in this region. Many large fields of this crop examined between Ilorin and Kishi were fairly heavily infested with white-fly and it is worth noting that the plants were practically 100 per cent infected with crinkle-leaf virus disease and that the laminar concavities thus produced provided a favourite hide-out for the white-flies.

Other host plants studied were sweet potato (Ipomoea batatas Poir, Convolvulaceae); tomato (Lycopersicum esculentum Mill, Solanaceae); Physalis pruinosa (Solanaceae); Calopogonium (Leguminosae); Vernonia sp. (Compositae); and Euphorbia heterophylla (Euphorbiaceae).

In a greenhouse experiment many females were introduced into an insectary containing known and suspected host plants, on 26th May, 1958. The list below shows the date and the order in which the plants were colonized with larvae.

Euphorbia heterophylla	6th June
Tomato	19th "
Cotton and cassava	1st July
Tomato	8th "
Calopogonium	16th "
Sweet potato	29th "

Papaw (Carica papaya Linn. Caricaceae) had not been colonized by 11th August 1958 on which date the experiment was terminated.

OVIPOSITION AND THE EGG

It is worth noting that the usual Aleyrodid oviposition pattern of spirals or concentric circles is entirely lacking in Bemisia tabaci. Apart from the grouping on the wax pavements on the tobacco leaf already described, the eggs are scattered over the underside of the leaves of host plants without any apparent design. On cassava they are often found on the upper surface of leaves as well but in these cases they emergent larvae evidently migrate to the underside since they are never seen on the upper side. The only feature regularly observed is that the egges are never laid on the leaf veins or even on the reticulum.

The egg possesses at its base a short pedicel which is the oviduct is folded back so as to lie close to the wall of the egg. It is inserted into the spongy mesophyll of the leaf and the responsive production of cork by the plant seals it in position. A channel running up the centre of the pedicel serves as a conduit for the spermatozoa and provides a means by which the egg can absorb moisture from the laminar tissue. Experiments to demonstrate the absorption by the egg of dyes via the leaf failed to provide conclusive results since the egg itself goes through almost the complete spectrum of colours in the course of its development. Fluorescein was tried but failed to appear in fluorescent form in the egg. But the dependence of the egg on leaf moisture can be demonstrated by a simple experiment. If egg-bearing leaves are picked and left to wither the eggs shrivel and die but if the petioles are kept immersed in water the eggs hatch.

PREDATORS AND PARASITES

By far the most efficient predator is Serangium cinctum Wse (Coccinellidae) which appeared in great numbers in April and initiated a fluctuating movement in the white-fly population lasting some six weeks. Towards the end of May it became scarce and ceased to exercise any control over the white-fly.

This is the first record of this beetle as a predator on Bemisia. It has previously been recorded from the Cameroons and from Sierra Leone attacking bamboo scale.

The only parasite recorded is the wasp Prospatella sp., Encyrtidae. It was found that the incidence of parasitism ranged from nearly 3 per cent

in the first half of the year to nearly 20 per cent in July and again in October. The mean incidence for the period March - June is 3.34 ±0.07 per cent; that for July - October 13.32 ±3.5 per cent. No difference in the incidence of parasitism was noticed on cassava and Physalis. But in tobacco there is a remarkable difference. In many thousands of pupae bred out for parasites over the period March - October, Prospatella was never recorded from Bemisia on tobacco. This is possibly due to the hostile trichomes on tobacco already mentioned.

SEX RATIO AND PARTHENOGENESIS

Studies on the sex ratio were continued. Random sampling of adults from tobacco in November and December gave the following results:-

Thirty samples totalling 11,474 adult white-flies collected at random in the field gave a mean M/F ratio of 0.011 ± 0.006 or 11 males per 1000 females.

Basing the sex ratio on adults bred out from pupae collected over the period under review on a variety of host plants in different localities, the following conclusions were reached. There was no difference in the M/F ratio according to host plant or to locality, but there was a seasonal difference. Grouping the data it was found that in June, July and August (total 2532 white-flies) there was a mean M/F ratio of 0.501 ± 0.029 whereas the months of March and April, May, September and October (total 7525 white-flies) gave a lower mean M/F ratio of 0.294 ± 0.021. The M/F ratio for the months November and December (total 835 white-flies) gave a still lower mean M/F ratio of 0.111 ± 0.02. It thus appears that the proportion of males decreases during the drier months.

Comparing the M/F ratio of random collection of adults in the field during November and December given above (0.011) with the M/F ratio obtained during the same period by breeding out pupae (0.111), it will be seen that the M/F ratio is only about 1/10th of what it would be if the males lived as long as the females. It may therefore be concluded that the male life span is 1/10th that of the female. This compares favourably with what was observed in the greenhouses where females live 20-30 days and the males 2-3 days.

In regimented captives bred from pupae in the insectaries, mated females produced progeny with an M/F ratio of 2.667 on cassava, 7.667 on cotton and 0.975 on tobacco.

Unmated females produced progeny with an even higher M/F ratio: 14.750 on cassava and 10.312 on cotton. Thus the proportion of males from field pupae is much lower than from that obtained from pupae bred in captivity even from mated females. At present it does not seem possible to assign any reason for this discrepancy.

Parthenogenesis was demonstrated in the genus Bemisia for the first time as far as can be ascertained from available literature. Unmated females reproduced on cassava and cotton without any trouble but seemed at first less able to do so on tobacco. However, it was later found that when older plants were substituted oviposition took place quite as readily as on cassava and cotton, giving in fact a reproductive index of 14.3 as compared with 7 on cassava and 9.4 on cotton. The M/F ratio of the progeny, however, was much lower, being only 1.6 as against 9.9 on cassava and 14.2 on cotton. This remarkable difference between young and old tobacco as white-fly host plants is almost certainly due to the secretory trichomes on the underside of the leaves which are less active in older plants.

It seems that not all unmated females can reproduce. In experiments the percentage of reproductive females was 52.8 on cassava, 81 on cotton and 36.4 on tobacco. If the reproductive index is calculated on the basis of reproductive females instead of on all females tried, as above, it becomes 13.2 instead of 7 on cassava, 11.6 instead of 9.4 on cotton and 39.4 instead of 14.3 on tobacco.

CHEMICAL CONTROL

Insecticidal trials against the white-fly Bemisia tabaci (Genn.) were carried out on cassava at Moor Plantation and on tobacco at Ogbomosho, using the chlorinated hydrocarbons Gammalin 20 ($\frac{1}{2}$ pint in 5 gallons of water), Dieldrin ($\frac{1}{2}$ pint in 5 gallons of water) and the organo-phosphorus systemic insecticide Rogor 40 or Fostion (1/10th pint in 5 gallons of water).

In the trial on cassava at the first sampling 22 days after spraying, the Dieldrin and the Rogor treatments differed significantly from the controls at the 0.001 level but not from each other. At the second sampling 42 days after spraying, all three treatments were significantly different from the control at the 0.001 level and Rogor 40 gave a significantly better control than Gammalin 20 but not better than Dieldrin. At the third sampling 66 days after treatment, only Rogor 40 gave significant control at the 0.001 level.

In the trial on tobacco at Ogbomosho all three treatments showed significant control at the 0.01 level at the first sampling 10 days after treatment. At the second sampling 31 days after treatment, only Rogor 40 gave significant control at the 0.01 level. At the third sampling 63 days after treatment only Rogor gave significant control at the 0.01 level. Rogor 40 therefore seemed to hold out considerable promise. But in a later trial also on tobacco at Ogbomosho using only Rogor 40 (1/10 pint in 5 gallons) in one and two applications sprayed on the plants and at 0.1 per cent concentration applied at the rate of 100 ml. per plant to the soil round the base of the stem, results completely failed to confirm the efficacy of Rogor 40. It is suspected that the Rogor 40 used, which was of the same stock as that applied in the previous two trials, had meanwhile deteriorated.

Coffee Berry Borer (F.A. Squire)

Insecticidal trials against the coffee berry borer, Stephanoderes hampei Ferr., were carried out in collaboration with Dr. F. Sands of the International Development Services Incorporated on the coffee plantation belonging to the Western Region Development Corporation at Isuoda, Owo, and on two private coffee farms at Ebute-Igboro. The insecticides used were different formulations of Endrin, Dieldrin and Gammlin 20.

At Ebute-Igboro the trial on one farm yielded no significant differences. In the trial on the other farm there were two samplings. The first 84 days after spraying analysis showed that all treatments were significantly better than the controls at the 0.001 level and that Endrin was better than Dieldrin but not significantly better than Gammalin. At the second sampling 98 days after treatment, all treatments differed significantly from the controls at the 0.001 level but not from each other.

The trial at Isuoda, Owo was sampled twice - 57 days and 76 days after the first spraying. The first sampling showed that Dieldrin in water, both one and two applications, and Endrin in oil, in two applications were significantly better than the controls at the 0.01 level. The second sampling gave only Dieldrin in water, in one application, and Dieldrin in oil, two applications, significantly better at this level. None of the treatments was significant at higher levels and there was no significant difference between the treatments.

Maize Stem-Borer (K.M. Harris)

An insecticidal trial against maize stem borers was carried out in collaboration with the Western Region Ministry of Agriculture and Natural Resources at Agege using Aldrin, DDT, Dieldrin, Endrin and Rogor. Data obtained from thin-outs indicate a very low incidence of stem-borers throughout including the control plots. Later stand counts and dissections of dead and moribund stands likewise gave very low counts. In the stem count at harvest no significant differences appeared.

Red Mite on Cassava (F.A. Squire)

The trial with N.V. Philips-Roxane Duphar-Tedion V18 against Tetranychus telarius (L.) was completed. It was found that control was achieved within five days of spraying. Maximum control was recorded eight days after spraying and control effects persisted for two months after spraying. It must be mentioned, however, that there was throughout the experiment a constant decline in the mite population of the controls so that the long-term control effects may be partly due to the fact that unfavourable conditions not connected with the application of Duphar-Tedion had begun to operate against the mite. In such circumstances a population decimated by chemical control might tend not to recover even after the effect of the acaricide has ceased to operate.

Entomological Records (F.A. Squire)

The coffee trunk borer, Bixadus (Monohamus) sierricola White (Lamiidae, Coleoptera) was recorded doing severe damage to coffee trees in the Cameroons. Surprisingly, this beetle has not previously been recorded from Nigeria although it is widely distributed in the Guinean belt extending from French Guinea to Uganda. From reports it appears that quite young trees of three or four years were being attacked and many killed. The life-history of this beetle is well known. Unfourtunately it nearly all takes place inside the tree trunk so that control measures can be effectively applied only during the brief space between the laying of the egg and the penetration of the tissue by the young larva. The adult is very short-lived and eggs are deposited in crevices in the bark as soon as it emerges from the pupa.

OOTHECA MUTABILIS SAHL: (Galerucidae, Coleoptera)

A severe outbreak of this beetle occurred on cowpeas during June and was effectively suppressed by an application of Gammalin 20. An examination of several hundred specimens revealed the existence of three forms: brown elytra, black elytra and intermediate forms with the anterior portion of the elytra black. Of these the entirely black forms were very scarce, amounting to only two in several hundred whereas the pure brown form was rather more numerous. The great majority belonged to the intermediate grade.

At the same time the Federal Plant Pathologist reported the experimental transmission of a virus disease of cowpeas by this beetle. There were thus two good reasons for establishing a breeding colony of Ootheca mutabilis. Unfortunately an unexpected difficulty arose. In spite of an intensive search in the field and trials in captivity the larval host plant could not be determined and the attempt had to be abandoned.

HELOPELTIS ON CASHEW

During a visit to the Eastern Region Development Corporation's cashew plantation at Enugu very severe damage due to Helopeltis sanguineus Popp. was observed. A very high proportion of the young shoots destined to bear inflorescences were killed off and many of the inflorescences and fruits were attached and severely damaged. The direct loss in yield due to this capsid must be enormous quite apart from the long-term effect due to the stunting of the trees as the result of repeated attacks.

POTATO TUBER MOTH

The potato tuber moth, Phthorimaea operculella Zell. was bred out from imported potatoes on sale in Lagos. This is the first record of this insect from West Africa. It is not known whether it has succeeded in establishing itself on local host plants.

YELLOW TRAYS

The operation of Moericke yellow trays was continued at Moor Plantation but not at Badeggi. The species of aphids and psyllids taken were mostly the same as in the previous half year. But two species of aphids, Geoica lucifuga (Zehntner) and Hallaphis nigeriensis Eastop, formerly recorded only from Badeggi, appeared in the Moor Plantation catches.

Biology and Control of Yam Beetles (J.L. Gregory)

BEETLE FLIGHT

It has been known for some years that Heteroligus meles adults are attracted to light after sunset during April to June when the beetle is migrating from the breeding area to the yam fields for feeding, but little has been known about the regularity and factors affecting the flights. Consequently a light trap was operated at the West African Institute for Oil Palm Research near Benin between 7 and 9 p.m. from February 10th to March 18th and from April 5th to July 26th inclusive. The first yam beetle was seen flying to light in a house at W.A.I.F.O.R. on April 3rd.

The first and last at the light trap were recorded on April 7th and June 26th respectively.

Yam beetles were attracted to light from sunset onwards, with peak flights from 7.30 - 8.15 p.m., numbers tending to fall off thereafter. On occasions when many beetles were flying, the first usually came to light earlier than on nights when few were attracted to the trap. The average number recorded on nights when the first arrived between 7.00 and 7.15 p.m. was 53.5 beetles whereas an average of only 9.8 followed a first flight between 7.30 and 7.45 p.m. If none had flown in by 8.30, none were recorded for that night.

There was a distinct correlation between rainfall and the number of beetles flying afterwards. Beetles were observed flying to the light trap on 48 evenings during the period of flight. Rain had fallen in the previous 24 hours on 24 of the evenings on which flight was observed and these 24 evenings accounted for 754 of the total of 976 yam beetles collected. On fifteen evenings out of the 48, more than 10 beetles were recorded. Ten of these fifteen had been preceded by rain in the previous 24 hours. There was a large flight after every considerable fall of rain unless the rain had fallen in the afternoon too close to the time of flight, or unless the temperature at the time of flight was too low.

The probability that beetles will fly, and the size of flights were affected by air temperature. A continuous temperature record of the time the light trap was working showed that the temperature between 7 and 9 p.m. over the migration period varied from 72° to 90° F. Yam beetles were attracted to the light trap from 72° to 86° F, and were much more likely to fly between 77° and 82° F than at higher or lower temperatures.

The proportions of the two sexes taken at the light trap in the three months was almost constant being 43.0, 46.3 and 43.8 per cent males in April, May and June respectively. There was some indication in April that made beetles flew earlier than the females, but this was not repeated in May and June. There were more males than females in the first hour the light trap was operated and less in the second. Male beetles tended to be more persistent in April, the proportion of males being greater on nights when few, and smaller when many, beetles came to light, but the above characteristics were not repeated in May and June when males and females tended to act similarly.

Newly emerged beetles are light brown in colour but this gradually changes to black. This darkening process is not fully understood. Changes in the colour of beetles taken at the light trap throughout the season were observed. The proportion of black beetles was greatest at the beginning of the flying period, decreased until about the third week in April and increased again slowly thereafter. This seems to indicate a waiting period between the time of emergence of the adult beetle and migration, while the beetle darkens in colour, particularly at the beginning of the flying period.

In November 1956 yam beetles were observed at light at W.A.I.F.O.R., the first record of flight at this time of year since 1927. This was thought to represent the return migration to the breeding areas for egg laying. Accordingly, a light trap was again operated nightly (with 6 exceptions) from November 1st 1958 until December 29th, one month after the last beetle was taken at the trap.

Beetles first came to the light trap on November 11th and the last was seen on November 29th. Forty-seven beetles were taken over a period of 19 days as opposed to 899 in 85 days in April. Therefore the return migration period at W.A.I.F.O.R. is shorter and apparently the beetles are much less attracted to light since it is unlikely that only 5 per cent of beetles migrating in the April to June period would still be alive to return to the breeding areas. This explains why, although the early "feeding flight" has been so widely observed in the past, there are only two previous records of the "egg laying flight" in November.

Results were received of nightly counts of yam beetles attracted to light during the 1957 flight period at Lowlands Farm, near Shendam in Plateau Province. Counts were made at 9 p.m. in a constant area of the verandah of the Agricultural Officer's house. The first beetle was seen on May 26th and the last on August 8th, almost two months later than at W.A.I.F.O.R.

There was a distinct though imperfect correlation between the number of beetles found at light and the rainfall in the preceding two days. There had been a sizeable fall of rain either that day, or on the preceding day on 10 of 13 nights upon which more than eight beetles were counted. The average number of beetles counted on the day of, plus the day after, rains of less than 0.5 inches, or with no rain at all, was 11.6. The corresponding figure for rains over 0.5 inches was 42.3 beetles.

Some large beetle counts did not follow rainfall and this may have been caused by difference in the rain falling at the breeding site (whose location is not known) and at the counting site, or due to the other factors affecting beetle flight mentioned above.

OBSERVATION PLOT

Concurrently with the operation of the light trap, observations were made upon yam beetle biology on a plot of yellow yams (*D. cayenensis*) planted "on the flat" at W.A.I.F.O.R. on March 29th. The length of each yam vine above the soil was measured daily, until it reached four feet long. Twenty yams were dug up weekly commencing one month after planting. They were examined for damage and the soil around each searched for beetles.

Daily observations of the yam hills for holes caused by insect activity were made from 20th May until all plants were harvested. Four categories of holes were observed, namely yam beetle entry holes, exit holes, holes not caused by yam beetles and undetermined holes. The observations were confirmed when the yams were harvested.

Observations on beetle entry made after the daily observations began showed that beetles entering the soil often leave holes very similar to those originally called exit holes. So all holes originally recorded as yam beetle entry holes or exit holes in hills which had attacked yams at harvest may safely be considered as yam beetle entry holes. Probably in all holes not thought to be caused by yam beetles, this determination was correct, since records began some time after the yam beetles started flying, so that all entry holes were not recorded.

Using this criterion, 59 (44 per cent) entry holes were within a radius of one inch from the yam vine and 122 (90 per cent) within five inches. It should be pointed out that these figures for the distance of entry holes from the vine apply to yams planted "on the flat", i.e. where ridges and hills had not previously been prepared, and they may not apply to other methods of planting. Observations on yams planted on hills at Lowlands Farm, Shendam showed entry holes up to 18 inches from the vine, although beetles still entered quite close to the yam foliage which was touching the ground.

Beetles entered hills with vines over four feet long in 96 per cent of all entries observed. There was some correlation between the number of beetles taken at the light trap and the number of holes observed in yam hills on the following morning. No yam beetle holes were observed after June 24th whereas the last beetle was taken at the light trap on the 26th June. Beetle entry into yam hills is thus fairly closely related to the number of flying beetles. It seems that after beetles enter the yam hills they do not leave the soil again until the time for the return migration to the breeding area.

Weekly random sampling of yam tubers began on April 29th and continued until the last yams were harvested on December 16th.

Evidence was gained about the length of yam vine attacked which confirmed those obtained from observation of entry holes. The longer the yam vine the more likely it was to be attacked. No yam whose vine had not appeared above the ground before it was dug up was attacked, and the smallest vine infested

of yams

by yam beetle was one foot long. Only 5 per cent whose vines were dug up before they reached four feet were attacked. The infestation rate of sampled yams gradually increased as the vines increased in length until about 12 feet, after which the attack remained fairly constant at about 55 per cent.

No yams whose vine first showed above the ground after the end of the flight period became attached. Thus the attack rate depends very largely upon the length of the yam vine at the time of beetle flight and it should therefore be possible to plant yams so as to miss the main attack merely by planting about one month before the end of the flight period, or, if desired experimentally, to plant so as to get as much beetle attack as possible.

Despite the correlation between beetle flight and the entry into yam hills, the number of attacked yams in the sampled specimens continued to rise slowly after the period of beetle flight, indicating some underground movement of beetles. Correlated with this was a corresponding diminution in the percentage of attacked yams near which beetles were found at sampling. This percentage decreased slowly and irregularly from 80 - 85 in the early part of the sampling period to about 50 in early November. On November 11th it had dropped to 8 and no yam beetles were seen in yam hills after this date, because all beetles had left the yam hills on the "egglaying flight".

BEETLE MATING

Beetles were kept in the laboratory and watched for mating and egg laying. Mating was first observed in the laboratory on October 11th and last on December 19th. Regular observations on mating behaviour were not made but the peak of observed matings was in early November, half being recorded between November 4 and 11th inclusive. Mating took place beneath the soil in cages in the laboratory.

Sometimes beetles have difficulty in separating after mating and die soon afterwards, leaving genitalia protruding. Observations of this may indicate the frequency of mating. Dead beetles with protruding genitalia were noted between October 14th and December 22nd, half occurring between November 3rd and 19th. These figures correspond roughly with those of observed matings and with the dates of the return migration.

It is almost certain that the dates for mating and those for egg laying given below are earlier than occur in nature. Beetles began their egg laying migration at W.A.I.F.O.R. on November 11th by which date more than 2,000 eggs had been laid in the laboratory. They were also flying at Onitsha on November 10th to 13th and November 28th and 29th and presumably also between these dates. It would appear therefore that present conditions in the laboratory do not bring about normal oviposition and mating and that the conclusions as to mating and also egglaying times and numbers of eggs laid should be treated with some reserve.

EGG LAYING

The first eggs were laid in the laboratory on October 6th and the last on January 31st. Between these dates 7,008 eggs were laid, 3,824 (55 per cent) in the month of November.

The egg is small, creamy white and oval and weighs about 0.013 gm on laying. If eggs are exposed to the air they often burst almost at once, particularly if the atmosphere is cool and dry. Prolonged exposure to the atmosphere will cause desiccation and death of the eggs in about two days. During normal incubation they increase in size and weight to about thrice the original, owing to the absorption of water.

After several trials it was found that the best method of rearing them was to place them singly in small tubes and cover them with moist soil. Under these conditions it was possible to get about 90 per cent hatching. However, only 2,425 eggs finally hatched, since it was not possible to give optimum conditions to the large number of eggs being reared and also because some eggs were used for experiments. The average incubation period was 14.5 (range 7 to 36) days; 90 per cent hatched between 13 and 16 days, and 69 per cent

between 14 and 15 days after laying. Eggs kept in less favourable conditions are less likely to hatch and take a longer time to do so. Preliminary observations showed that moisture conditions were very important in the incubation of yam beetle eggs. Separate batches of eggs were then kept in tubes over sulphuric acid solutions designed to keep the relative humidity at 70, 75, 80, 85, 90, 95 and 100 per cent. There were two batches of eggs at 100 per cent relative humidity and in one of these the eggs were also in contact with liquid water (as opposed to water vapour only in the other jars).

All the egg batches lost weight due to desiccation except the two at 100 per cent R.H. Eggs exposed to relative humidities of 85 per cent or less lost water, collapsed and died, often within the first 24 hours. Only the eggs in contact with free water gained weight, indicating that it is necessary for eggs of yam beetles to be in contact with free water for successful incubation.

This fact is obviously of the greatest importance in determining the conditions in which eggs can be reared successfully. Eggs may be laid almost anywhere (one female yam beetle laid an egg in an empty jam jar exposed to the air). But in order for the egg to absorb sufficient moisture for normal development free water must be available. There are few places where the soil is in such a condition at the time of beetle flight (mid-November) and almost certainly this is why H. meles breeding grounds appear to be so restricted.

BIOLOGICAL CONTROL

Further species of parasites and possible parasites were found during the year including the cysticercus of a tapeworm which presumably lives in some insectivorous animal, but it is unlikely that any of the new parasites are of significance in controlling yam beetles.

YAM BEETLES OTHER THAN H. MELES

A new species of yam beetle has been found during the year bringing the number of species of Dynastid beetles attacking yams in Nigeria up to four.

Heteroligus meles Billb. is the common yam beetle, to which all of the above information applies.

Heteroligus appius Burm. has been recorded from quite a wide area in the past. During the year it was recorded in the experiments at Ozubulu and Oraifite in Onitsha Province. H. appius represented 33, 9 and 3 per cent of the total yam beetles found at the three experiments in August, but may have become more important later as there are indications that it reaches the adult stage later in the year than does H. meles.

Prionoryctes canaliculus Arrow was observed in Bodo, Dere and Etee in Ogoni Division of Rivers Province. It was recorded from Bori in this Division in October 1950 and at Opobo in September 1936. P. canaliculus is the name originally ascribed to the "yam beetle" in Nigeria by A.D. Peacock (Bull. Ent. Res., 1914, 4, 215). It has seldom been noticed since probably because it appears to be a species of the mangrove forest and coastal vegetation zone and little work has been done in this zone. Little is so far known about it. On various dates between July to October, it formed between 10 and 35 per cent of total yam beetles found at the sites mentioned.

P. sp. probably rufopiceus Arrow was first reported as attacking yams from Umudike in August 1958. It was recorded from Olokoro (also in Bende Division of Owerri Province) in early December. A specimen in the Ibadan collection was collected at Calabar on 26th August 1930. One female of this species laid several eggs early in October but they did not hatch.

The other species are not as important as Heteroligus meles except in the southern Awka to Afikpo area where H. appius is predominant. In other localities their significance may lie in the difference in time between their life cycle and that of H. meles. If the adults fly and attack yams at a different time of year different from H. meles, then any insecticidal control will have to be efficient for a longer period. It is obviously important to find out something about the life history of these species.

YAM BEETLE CONTROL EXPERIMENTS

Eight experiments were laid down in 1958 to find out the effect of various insecticidal treatments upon yield of yams and yam beetle damage.

New methods of application were tried, namely spraying or dusting on top of the hills at planting time or about the time of beetle flight in early planted yams, and spraying the holes before planting.

Two experiments were designed to test the effect of applying insecticides to the surface of the yam hills after planting. The plots were located in Rivers Province on yam farms; one plot had been planted in December 1957 and one in January 1958.

The insecticides used were Aldrin and Dieldrin emulsion concentrates and Chlordane wettable powder applied as sprays and 2.5 per cent Aldrin as a dust. They were applied on May 7th.

In both these experiments treatments did not lower the attack rate appreciably. There were some yield increases but these were not statistically significant and could not be compared with corresponding decreases in damage; they should be discounted.

The six experiments upon later planted yams gave more decisive and valuable results. They were designed to confirm the results of earlier experiments on the effects of various seed dressings on the yield of yams and yam beetle attack, and to compare these with insecticides applied to the planting holes before, and to the surface of the yam hills after, planting.

The attack rate in all trials was very low and did not test the treatments severely. Yield increases were therefore lower than in the previous year.

A 2.5 per cent Aldrin seed dressing was again the most successful at decreasing yam beetle attack and causing a corresponding yield increase. In four experiments, it decreased yam beetle damage by 19 per cent (79 per cent of the total attack rate on untreated plots) and increased yield by an average of 550 lb (8 per cent of the yield on untreated plots). The rate of application on these plots averaged 27 lb (about 36/- at 1/4d per lb). The minimum value of yams is 10/- per cwt so that even at these low attack rates it is still economical to use Aldrin, even without considering the increased value of undamaged yams.

In six experiments Gammalin A seed dressing increased yield by an average of 750 lb per acre (10.4 per cent of the yield on untreated plots) and decreased damage by 19 per cent (79 per cent of untreated attack rate). It thus appears better than Aldrin, but in experiments in which the two were compared Aldrin gave better control of beetle damage and a better overall yield increase, though it was not so convincing in the latter respect.

Five per cent Chlordane and 2 per cent Dieldrin seed dressings decreased beetle attack and increased yield but were not so good as Aldrin.

Agrocide 7 was the most effective insecticide in controlling yam beetle damage, but in all three experiments in which it was tried treated plants gave lower yields than untreated ones.

An attempt was made to control yam beetle damage by applying Gammalin A into the planting holes before planting. The machine used was unfortunately defective and applied only about 10 lb per acre. It increased yield and decreased damage but the Gammalin A seed dressing at 24 lb per acre was significantly better in both respects.

Aldrin, Dieldrin and Chlordane were applied to the planting holes from a knapsack sprayer. In general it may be said that at the concentrations used the insecticides caused some decreases in damage, but these decreases were not as marked as those caused by dressing the yam setts before planting. Aldrin proved the best of the three insecticides used in this way.

This method of control of yam beetles is to be further studied, although, unless it is distinctly better than the seed dressing method, it is unlikely to be adopted by farmers owing to the ease and convenience of seed dressing.

Insecticides were applied also on the surface of the hills but none of the sprays and dust used gave any appreciable control of yam beetle damage.

Four experiments were laid down in December 1958 in Delta Province to test the effect of Dieldrin and other dusts used as seed dressings upon yield of yams and yam beetle attack. They are to be compared with other insecticidal treatments applied to the soil surface at the time of beetle flight.

METHOD OF ACTION OF SEED DRESSINGS

The results of the observations made upon the plot at W.A.I.F.O.R. give a clearer idea of the method of action of insecticidal dressings. The present conception of how the insecticides are controlling yam beetles is given below. Let us consider yams planted late in March as the yams were at W.A.I.F.O.R. last year. Insecticide is applied to the yam sett which is immediately planted in the ground. Some of the insecticide becomes detached and mixed with the soil around the sett but most of it stays on the yam sett itself. The yam sett sprouts and starts to grow but the flesh does not deteriorate rapidly and is still palatable to yam beetles.

The beetle begins to fly, as in most parts of the Western and Eastern Regions, early in April. As soon as the vine shows above the ground, the yam plant is liable to attack but is not usually attacked unless the vine is above four feet long. The beetle is attracted to the vine, enters the yam hill and begins to feed on whatever yam is present, in this case the sett. The beetle thus takes in insecticide either by contact or ingestion and dies.

Beetles fly nightly for about three months in any one area, and by far the greater part of attacked yams are attacked by beetles which enter the yam hills after flying as there is comparatively little movement of beetles under the ground. Thus attack takes place chiefly over a period of three months. The seed yam is still palatable to yam beetles at the end of June when beetle flight ceases and if the insecticide is still toxic, then the attacking beetles will still be killed.

It is possible that some insecticide is present and kills beetles which attack the newly forming yam, but almost certainly the main insecticidal action depends upon control of beetles attacking the seed yams. Some beetles may also be killed as they move about the yam to feed, moving through soil impregnated with insecticide which has been transferred from the seed yam.

It appears that sett treatment must be the most effective method of control (since the insecticide is placed where attack occurs) provided that toxicity is still retained at the time the beetle enters the yam hill.

When the sett is planted earlier or the beetle flies later, the seed yam is less likely and the new yam more likely to be present when the beetle enters the hill, and therefore control is less likely to be effective. Also the toxicity of the insecticide gradually decreases with time. It is for these reasons that control on earlier planted yams is not as effective that as upon late planted yams.

Cereal Pests (K.M. Harris)

STEM-BORERS

Northern Region

During the past three years stem-borers of cereals have been closely studied at the Regional Research Station, Samaru, Zaria. The most important borers there are Busseola fusca on guinea-corn and maize and Coniesta ignefusalis on millet. The life histories and seasonal biology of these species are now sufficiently well known to justify the application of knowledge obtained at Samaru to the solution of stem-borer problems in the Provinces and one of the main aims of work done in the year 1958-59 was to discover whether such an extension is feasible.

The Provinces of Kano, Katsina, Niger, Ilorin, Kabba, Benue and Plateau were visited during the growing season and in addition Provincial Officers co-operated in a survey of crop residues in which all provinces of the Northern Region were represented.

In Kano, Katsina, Zaria, Plateau and Northern Niger there is little variation from the stem-borer regime observed at Samaru. B. fusca is dominant in guineacorn (and in maize in areas where it is grown) and C. ignefusalis is dominant in millet, except on the Jos plateau where preliminary observations suggest that it may be absent. Both species enter diapause at the onset of the dry season and the survey of crop residues has shown that high populations of diapausing larvae are present in guineacorn and millet stems in Kano, Katsina, Sokoto, N. Niger and Plateau. Many of these samples indicate the presence of very high populations and at Daura 377 larvae of C. ignefusalis were found in 100 millet stems.

The importance of crop residues in carrying stem-borer through the dry season in the more northern Provinces has now been adequately demonstrated and it is expected that in the near future farmers may be educated to methods of crop sanitation which will reduce the carry-over population and minimise stem-borer attack in the early growing season.

Such measures will be effective only in those areas where B. fusca and/or C. ignefusalis are of primary importance. In the more southern Provinces other species are also important, stems of guineacorn and millet are less widely used for building, and alternative grass hosts and tillers growing from stubbles may be of considerable importance. A separate research programme in these areas should be completed before definite recommendations can be made.

Applications of insecticide to guineacorn and millet have, on the whole, shown little promise of controlling B. fusca and C. ignefusalis and have been temporarily suspended while stem-borer biology is further investigated.

Ibadan

An economic increase in yield can be obtained by applying insecticide to the second maize crop at Ibadan. Unfortunately Endrin, which has given the best results, is too toxic to be used by farmers and an attempt is being made to determine whether some of the less dangerous insecticides may give sufficiently good control of stem-borer to justify recommendation to the farmer.

SORGHUM MIDGE SURVEY

The sorghum midge survey first carried out in 1957 was repeated in 1958. All Provinces of the Northern Region were covered and 522 samples were received. From each of these a sub-sample of 50 spikelets was taken and dissected and 176 of the sub-samples contained larvae and/or pupae of the sorghum midge Contarinia sorghicola. Three per cent of the 26,100 spikelets dissected had failed to produce grain as a result of midge attack. A more detailed report is being prepared.

RICE STEM GALL MIDGE

A stem gall midge was collected from rice at the Federal Rice Research Station, Badeggi and at Lowlands Farm, Shendam. This was later identified as Pachydiplosis oryzae Wood-Mason, a pest of rice in India and Pakistan. The attacks at Badeggi and Shendam were not severe.

SWEET POTATO VIRUS

Two varieties of sweet potato out of eighteen have been found to show no symptoms of 'internal cork virus'. Leaf symptoms of this disease have been correlated with the symptoms in cut root samples. In the roots the virus is recognised by brown aggregates of sclerotic cells. The prevalence of these aggregates increases with storage and the tubers become less suitable for market.

Advice on this work on virus diseases of sweet potato is being given by Dr. W. Stoner, I.D.S., who has undertaken identification of the viruses.

Suspected virus disease of Citrus (J.M. Waterston)

Acid lime trees budded on sour orange inthe rootstock trial at Moor Plantation, established in 1955, showed severe symptoms of tristeza virus disease for the first time in September 1958, three years after planting. The affected trees had chlorotic foliage which showed the characteristic symptoms of clearing and flecking of the leaf veins, as well as shortening of the shoot internodes accompanied by defoliation. The other rootstocks appeared to be healthy, as did the seedling trees. Comparative tree sizes at three years, taken as the cross-section area in square centimetres measured six inches above the bud-union (or at two feet in the case of seedlings) were as follows :-

Sampson Tagelo 75, rough lemon 50, sour orange 34, seedling 21. Experiments to obtain formal proof of the presence of the virus have yet to be carried out.

Additional evidence of the presence of tristeza was obtained from the Agege I sweet orange rootstock trials, established at Ibadan in 1952. Trees on sour orange failed to make satisfactory growth and are now moribund. Four out of sixteen trees have died within six years from planting.

The first death occurred at four and a half years from planting in the field but some showed symptoms of chlorosis in 1952. Comparative tree sizes in square centimetres at seven years were as follows :-

Lake Tangelo 100, Cleopatra tagerine 96, Sampson Tangelo 72, sweet orange 58, rough lemon 50, sour orange (a) Trinidad 24, (b) Moor Plantation 23 It is significant that the combination sweet orange/sour orange shows the least growth. This is the stock which is most likely to be affected by tristeza virus. Seedling sweet orange trees used as a control were the largest, 142. This is to be expected as seedling sweet orange is not known to be affected by tristeza.

Sour orange stock previously proved one of the best for both sweet oranges and grapefruit in the 1932 trials at Ibadan. Its recent poor performance suggest that tristeza has entered Nigeria sometime during the last twenty years, as has occurred in Ghana.

STRIGA RESEARCH

During the past year the following work on Striga has been carried out atthe Botany Department, U.C.I.

The effects of certain conditions of mineral nutrition on the Striga/host relationship have been studied in greenhouse experiments.

The germination and pre-penetration growth of the parasites have been studied in the laboratory, together with growth factors present in the seeds.

An insect attacking Striga and Sopubia (a similar parasite) has been collected and identified.

It is clear that nutritional status can affect the host/parasite relationship in two ways: by enabling the host to make good growth as well as supporting an appreciable growth of parasites, and by affecting the viability of the parasite's seeds before contact is made with the host. There is, however, no evidence that the actual resistance of the host to attack is affected by nutrition.

LIBRARY

The Federal Library has expanded greatly during the past year though it is still hampered by lack of money and equipment. Forty new journals are being received, making a total of approximately 120 journals currently taken. An additional 200 books, chiefly on soils, chemistry, meteorology and statistics, and a considerable amount of pamphlet and reprint material have been obtained. The issue of monthly accessions lists has been continued.

With the appointment of two library assistants, some of the backlog of sorting and cataloguing early material has been dealt with. All the books (now numbering about 1200) and three-quarters of the pamphlet material have been catalogued in subject and author catalogues.

Much time has been spent on trying to replace missing issues of journals so that binding can be started. The problem of unwanted duplicates and missing issues appears to be common to all special libraries in West Africa and lists of our duplicates and requirements have been circulated to other special libraries in the hope that exchanges of material may be encouraged with mutual benefit. This is especially desirable in view of the fact that journal issues very quickly go out of print and therefore back numbers are unobtainable from the normal suppliers.

A list of Departmental reprints has been prepared and the Library is now in a position to send exchange material to many outside organisations from whom much material has been and is being received.

Records kept during the year show that the Library received approximately 100 general enquiries from within the Department and from ten outside organizations. Users of the Library average 30 per month and loans 25 per month.

PUBLICATIONS

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1959(b) Studies on Puccina polysora Underw. III. Description and life cycle of P. polysora in West Africa. Trans. Brit. mycol. Soc., 42 (1): 55-58.

Chant, S.R.

1958 Studies on the transmission of cassava mosaic virus by Bemisia spp. (Aleyrodidae). Ann. appl. Biol., 46 (2): 210-215.

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Clayton, W.D.

1958 Secondary vegetation and the transition to savanna near Ibadan, Nigeria. J. Ecol., 46 (2): 217-238.

Williams, C.N.

1958 The parasitism of witchweed - a review. W. Afr. J. biol. Chem., 2 (3): 57-73

Table 1. Rate of Recruitment of Specialist Staff in the Federal Department of Agricultural Research (including 3 posts in the West African Maize Research Unit and 2 posts in the Colonial Development and Welfare Soil Fertility Unit) as at March 1952 - 1959.

Specialist Establishment	1952	1953	1954	1955	1956	1957	1958	1959	Total
Authorised	19	19	19	20	20	26	46	46	-
Actual	9	11	11	13	15	14	15	20	-
Recruits	-	2	1	4	3	3	3	9	25
Retirements or Transfers	-	-	1	2	1	4	2	4	14

Table 2 YIELD OF NINE VARIETIES OF COFFEE (TREES PLANTED 1932)

Species and Variety	Spacing (ft.)	Trees in bearing (%)	Yield 1958-59 (lb. fresh cherry/ acre)	Yield 1957-58 (lb. fresh cherry/ acre)
Coffea arabica	8 x 8	39	108	42
C. canephora				
var. Gold Coast robusta	12 x 12	88	4,498	.574
var. Quillou robusta	12 x 12	80	1,430	1,412
var. Uganda robusta	12 x 12	88	1,212	970
var. Java robusta	12 x 12	77	1,038	166
C. excelsa	12 x 12	94	2,990	230
C. stenophylla	10 x 10	75	754	518
C. Liberica plot I	12 x 12	85	622	618
C. Liberica plot II	12 x 12	88	634	798

Table 3. PERCENTAGE BERRY BORER INFESTATION AT FIVE HARVESTS IN NINE VARIETIES OF COFFEE ON MOOR PLANTATION

Species	27/10/58	17/11/58	17/12/58	19/1/59	18/2/59
Coffea arabica	5	12	-	-	-
Coffea canephora					
var. Gold Coast robusta	19	32	54	82	
var. Quillou robusta	38	59	63	86	
var. Java robusta	26	23	64	87	
var. Uganda robusta	24	30	51	70	
Coffea stenophylla	29	18	55	-	-
Coffea excelsa	-	-	26	7	26
Coffea Liberica plot I	18	22	76	-	-
Coffea Liberica plot II	13	9	35	-	-

Table 4. LOCUST ACTIVITIES IN NIGERIA:
1ST APRIL 1958 TO 20TH FEBRUARY, 1959

	Locality	Direction of Flight	Area	Stage	Colour	Identification
3/5/58	Birnin Kebbi	N	2 miles square	Adult	Pink	Desert Locust
6/5/58	Bayawa	NE	1 mile square	"	"	"
3/6/58	Gada	-	Small	"	"	"
7/6/58	Yusufari		"	"	"	"

Table 5. Meteorological Data for Moor Plantation, Ibadan, 1958

Month	Rainfall				Mean RH % 0900 GM T	Mean Temperature at 0900 G.M.T.		
	Inches	(Days)	Cumulative Total (Inches)	Previous Average 1948–57 (Inches)		Max. °F	Min. °F	Mean. °F
January	0.04	3	0.04	0.37	84.4	92.2	70.3	81.2
February	1.92	4	1.96	1.05	76.0	94.7	69.3	82.0
March	2.90	7	4.86	3.25	79.0	95.1	73.5	84.3
April	1.91	11	6.77	5.89	82.0	91.9	72.1	82.0
May	6.93	19	13.70	5.90	81.2	88.6	70.9	79.8
June	9.56	26	23.26	6.90	86.3	83.9	70.2	77.0
July	0.11	11	23.37	5.49	82.6	81.5	67.1	74.3
August	1.91	10	25.28	3.18	82.3	82.5	66.8	74.6
September	3.02	26	28.30	7.94	85.4	84.4	69.6	77.0
October	9.22	22	37.52	7.28	83.0	87.3	69.4	78.3
November	2.79	11	40.31	2.01	82.5	89.3	71.0	80.1
December	–	–	40.31	0.30	76.3	91.2	70.9	81.0

Table 6. Meteorological Data for Badeggi Rice Research Station 1958

	Rainfall (in.) Badeggi	Average Rainfall (in.) Bida (30 years)	Mean Relative Humidity (%) 0900 GMT	Max. Temp. (°F)	Min. Temp. (°F)	Mean Temp. (°F)
January	1.66	0.12	63.9	92.7	66.5	79.6
February	0.38	0.30	42.8	95.4	62.7	79.1
March	0.00	1.10	60.8	100.7	74.4	87.6
April	2.49	2.94	67.6	97.3	76.6	87.0
May	4.96	5.94	75.6	92.7	74.1	83.4
June	5.38	7.28	80.0	87.9	73.3	80.6
July	1.01	8.12	76.4	87.8	74.9	81.4
August	6.43	8.20	80.3	86.0	72.4	79.2
September	10.88	10.10	82.8	88.2	72.6	80.4
October	4.34	4.36	75.6	90.4	72.9	81.7
November	0.95	0.30	73.0	93.0	73.0	83.0
December	0.0	0.00	64.0	93.0	68.0	80.5
Total	38.48	48.76	-	-	-	-

ORGANISATION OF THE FEDERAL DEPARTMENT OF AGRICULTURAL RESEARCH AS AT 31 MARCH 1959